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Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE GROSS AND NET EARNINGS of 146 railways for the month of October, according to the *Financial Chronicle*, are as follows:

	1891.	1890.	Inc. %.
Gross earnings	$73,055,349	$67,209,072	8.69
Operating expenses	45,120,897	41,996 970	7.43
Net earnings	27,934,452	25,212,102	10.8

This increase in net has been quite general, only 42 roads out of the total number showing decreases from last year's figures. Considering the various roads by groups the tables show that these groups have especially favorable exhibits, viz.: the Northwestern, Southwestern and Pacific. These groups show gains of 18.51%, 21.82% and 17.22%, respectively. The coal roads and the Southern roads follow next with gains of 12.34% and 11.42%. The Middle Western group shows a small gain, and the Trunk lines exhibit a small decrease.

THE BUREAU OF THE AMERICAN REPUBLICS has issued its annual report up to Oct. 31, 1891. This bureau was established on Nov. 20, 1890, by a unanimous vote of the recent International American Conference, for the main purpose of collecting and distributing commercial information concerning the commerce and resources of the American republics in the North and South America. The sum of $36,000 annually is appropriated for this purpose, assessed upon 18 governments in proportion to their extent and importance, the United States paying $18,806. Inquiries for specific information concerning commercial matters, chiefly from merchants and manufacturers in the United States, were received and answered to the number of 700 in the first 4 months, and have continued incessantly. Emigration has been stimulated, the export trade has rapidly increased between the United States and the Latin American nations, and the postal service is being improved. The chief publication of the bureau has been "The Handbook of the American Republics," a volume of 486 pp., concisely reviewing the condition and commerce of each of the American republics and colonies. Following this work 28 bulletins have been issued touching upon kindred subjects. The establishment of similar bureaus in England and France shows that the importance and influence of this bureau, in the promotion of American commerce, has been recognized in Europe.

A NIAGARA FALLS SHIP CANAL BILL has been introduced into the U. S. Senate by Senator DAVIS. It is intended for the passage of merchant and war ships around the Falls, and would be located in Niagara County, along one of the routes surveyed by the United States. The sum of $1,000,000 is appropriated by the bill for construction.

THE REPAVING OF BROADWAY, New York, following the laying of the cable conduit in that street, has been completed, and in 175 working days 2,500,000 granite paving-blocks have been laid. The contractor, Mr. JOHN D. CRIMMINS, claims that this is the largest number of blocks laid in the same time on one contract. The city retains 30% of the contract price until October of 1892, in addition to demanding two securities of $60,000 each for the faithful performance of the work.

A MINNEAPOLIS AND ST. PAUL-LAKE SUPERIOR SHIP CANAL is being discussed, and the two cities named offer to raise $2,000,000 to $5,000,000 for that purpose. The route proposed is by the Mississippi to Stillwater, the St. Croix to Northern Wisconsin and the Black River to Lake Superior. It would have a capacity equal to taking the largest whaleback boats now on the lakes.

BIRMINGHAM, ALA., has passed a resolution taxing and licensing almost every trade, occupation and profession in that city for municipal revenue. A study of the schedule shows that liquor dealers and railway and water corporations rank first in the scale, at $500 each. Auctioneers, pawnbrokers, building and loan associations, ice factories, hotels, &c., are rated at $100 each, and among the professions lawyers, doctors and dentists with incomes ranging between $3,000 and $5,000 per year pay $15 per annum, and under $3,000 per year, $10 per annum. Architects are taxed $25, and civil engineers and surveyors $10 per year each for each member of a firm. It costs $100 to deal in pistols or bowie knives in this live Alabama town, while an undertaker pays only $50 for the privilege of disposing of the "remains."

A NEW MACHINE GUN is being tested at the works of the Winchester Repeating Arms Co., at New Haven, Conn. It is the invention of the Browning Bros., of Ogden, Utah. Its principal feature is rapidity of fire, which is reported for a recent test as equaling 900 shots in one minute fired through one barrel. This gun has a water-jacket around the firing barrel and the cartridges are fed from a continuous belt. The Maxim machine gun has a record of 750 shots per minute. The detail of the new gun is not yet made public.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment, Dec. 18, on the main line of the Louisville & Nashville R. R., near Sheperdsville, Ky. The rails spread under a freight train, and the engine and several cars were wrecked. One man was killed and 3 were injured. It is said that the track was under repair, and that too many spikes had been pulled out along some of the ties. Another serious derailment occurred Dec. 17 on the Southern Kansas R. R., near Cherryvale, Kan. The express car, 2 passenger cars and a sleeping car were thrown down a bank, and were all burned, but all the passengers were rescued. Nobody was killed, but about 20 persons were more or less injured.

THE STONE ARCH BRIDGE, in Wheeling, W. Va., had its last ring stone laid on Dec. 17. It is a city bridge, 159 ft. clear span, 48 ft. wide and 28.4 ft. rise, It is a segmental arch of 125.46 ft. radius. The depth of the arch is 6 ft. at the spring and 4.2 ft. at the crown. The arch stones alone weigh about 3,600 tons, each ring stone varying from 3 to 7 tons in weight. Messrs. Hoge and White, the city engineers, designed the structure, and the contractors were Paigeo Carey & Co. and Hallock Bros.

YOUNG HYDRAULIC ENGINEERS are given some excellent advice in an article written by Mr WYNKOOP KIERSTED, of Kansas City, Mo., and published in the Troy *Polytechnic*, of Dec. 23. Mr. KIERSTED recommends a thorough technical training at some institution of high standing, to be followed by an engagement with some prominent practicing hydraulic engineer, as an apprentice rather than as an assistant, to begin with. After that he is fitted to assume a position of some responsibility and to design work for himself. The time then spent in the more subordinate positions will depend largely upon the individual himself and upon his unceasing reading of books and technical journals, deep study and the taking of notes in his specialties at every opportunity. Mr. KIERSTED recommends the careful noting down and tabulation of all practical information, to be gathered from many sources, such as the cost of work, time and methods of performance, tools and appliances used, &c.

The writer concludes with advice as to the later contact with municipal bodies, the political surroundings and the conditions upon which an engineer should accept service under these circumstances. Politics and engineering never make a successful combination, says Mr. KIERSTED. The relation of the engineer to the contractor is also treated of at considerable length, and under this head comes the letting of contracts. Space forbids more than a notice of this excellent paper; but a careful study of its full contents would be of benefit to young hydraulic engineers.

SURVEYORS' FEES IN CHICAGO have been fixed as follows:

Ordinary house lot, including street grade	$18.00
Survey alone	15.00
Grade alone	10.00

For subdivisions into lots in the open country and in plain rectangular work:

5 acre lots; per acre		$7.00
10	" "	5.00
20	" "	4.00
40	" "	3.75
80	" "	3 25
160	" "	3.00

Tracts of intermediate areas in proportion to the above fees. Subdivisions into blocks, without lots, one half the above fees. Surveying by the day for a party of three persons $25 per day and necessary expenses.

The surveys made are guaranteed correct, and the surveyor indemnifies the owner for his mistakes

The rates seem very reasonable, and doubtless many men of established standing will demand and receive considerable more.

THE UNDERWRITERS' ASSOCIATION in Chicago have raised insurance rates on high buildings. It is thought by prominent real estate men this will have the effect to permanently discourage the building of more high structures.

THE MEXICO DRAINAGE TUNNEL has been much impeded by water. In six months prior to November the contractors, Messrs. Read and Campbell finished 1,000 meters, a steady progress of 10 m. per mo. having been made on each working face when not interrupted by water. The loss from water so far incurred is stated at $1,800,000 which has been borne entirely by the contractors. A new contract justifying them for putting in the heavy additional pumping capacity needed, and in some measure indemnifying them for their loss, is now pending. When the contractors took the work over from the government 4,917 ft. of tunnel and 2,937 ft. of shafts was completed. Since then the contractors have completed (in two years) 6,885 ft. of tunnel and 840 ft. of shaft, and there still remains to drive 21.810 ft. of tunnel and 329 ft. of shaft. Fourteen pumps, aggregating 300 HP., have been lifting as high as 231,000 galls. per hour; 13 shafts with their headings are now being regularly worked, and machinery for the remaining 4 is in position.

SAILING VESSELS seem to be again coming into favor in Britain. There has been a sudden and great change in this respect within the past year or two. In evidence of this fact *Engineering* publishes the following tables:

MERCHANT VESSELS LAUNCHED IN BRITAIN.

Quarter.	Vessels.	Tons.	Sail to total.
September, 1891	236	981,651	23.6%
June, 1891	237	324,984	16.5%
March, 1891	154	243,422	16.5%
December, 1890	169	277,726	13.1%
September, 1890	180	306,577	10.6%
UNDER CONSTRUCTION.			
October, 1891	475	702,114	26.4%
July, 1891	530	769,300	21.4%
April, 1891	549	804,846	16%
January, 1891	471	734,010	15.4%
October, 1890	406	652,248	12.5%
July, 1890	464	739,914	11%
January, 1890	521	872,957	10.1%
October, 1889	521	882,749	9.75%

The causes for this decided change are as yet obscure, and *Engineering* does not attempt to summarize them.

Improvement in Skew Pin Connections.

In our issue of Oct. 17 last we illustrated and described an improvement in joints for trusses, invented by Mr. C. STEINER, C. E., of Chicago, Ill. Mr. STEINER now sends us a set of typical diagrams in which such skew connections would be useful and better adapted to exact calculation than is the present practice.

As the inventor remarks, pin-connections for metallic structures form an essential feature of American bridge construction. The practice was especially developed in this country, and its principal advantages in any new countries are easy and quick erection with the minimum of skilled labor. Its chief disadvantage, however, is that it confines the structure to narrower limits, as to form, than are possible in riveted construction. Both theoretical and æsthetical considerations make it desirable to have as much liberty as is possible and consistent with exact calculation in the design of structural work, and it is with this end in view that Mr. STEINER has devised the joint here referred to.

As to the comparative economical features of pin and riveted connections, there is some diversity of opinion; but American engineers as a body undoubtedly favor the first named type. Metallic bridges are usually made up of a continuous series of triangles, and for purposes of exact calculation it is necessary to assume that the several members revolve about some definite center or joint. This assumption is obviously an untrue and unsafe one to make when broad surfaces are connected by a mass of rivets; and it is also evident that in the case of skew connections on pins, or where the connected members lie in different vertical or horizontal planes, the revolution about this pin in ordinary practice does not meet theoretical requirements.

While pin connections approximate most closely to these requirements and reduce to a minimum those secondary moments which may amount to a considerable percentage of the total stress, the latter stresses are too often neglected, or rather assumed to be covered by the ordinary coefficient of safety. In the more important structures, and especially in bridges of intricate or special design, the influence of these secondary stresses may amount to a third of the total strain, and any means of more exactly defining them must be acceptable to engineers. The diagrams clearly show the necessity of some radical change in practice in this respect, and Mr. STEINER'S device seems to well meet the conditions imposed.

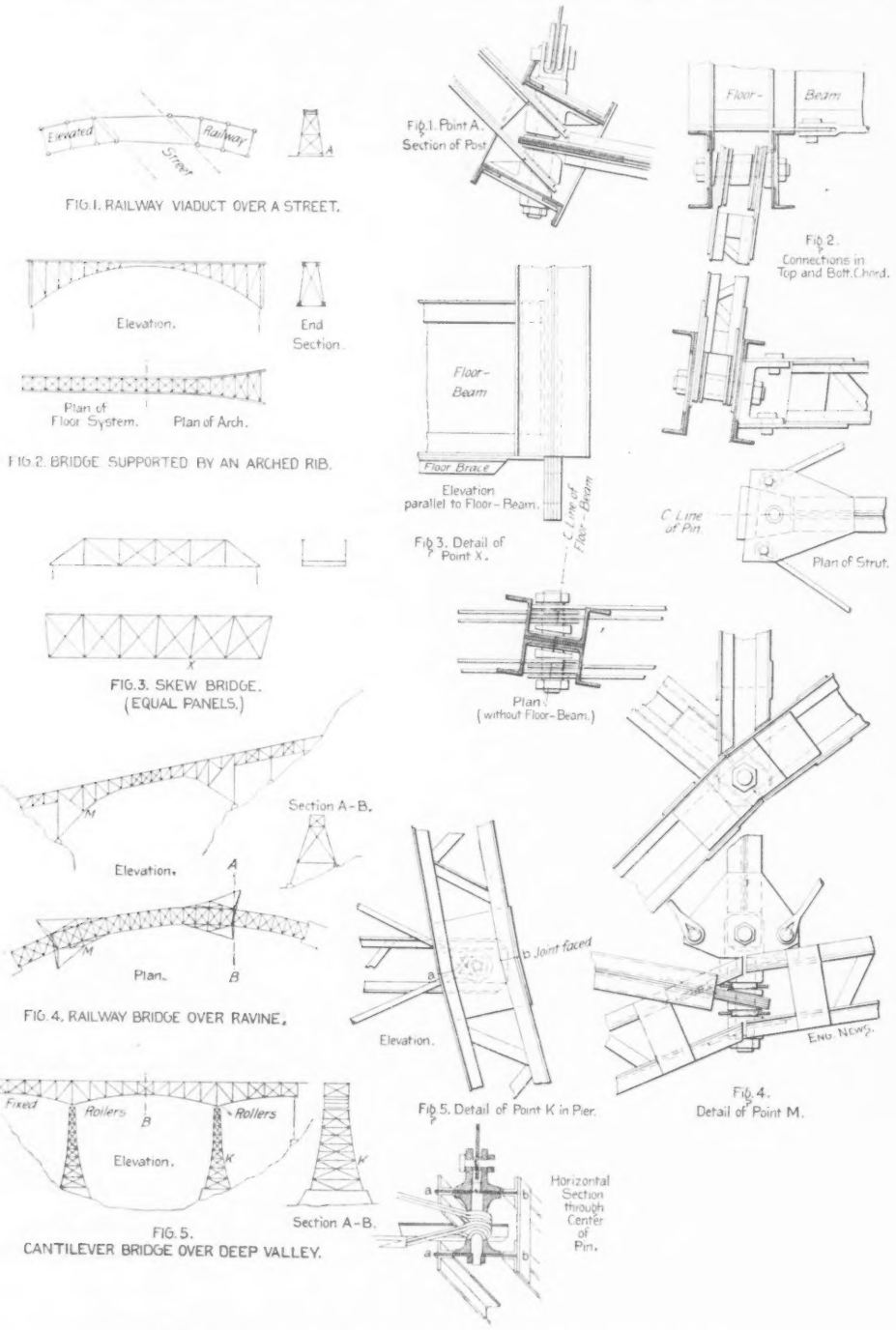


FIG. 1. RAILWAY VIADUCT OVER A STREET.

FIG. 2. BRIDGE SUPPORTED BY AN ARCHED RIB.

FIG. 3. SKEW BRIDGE. (EQUAL PANELS.)

FIG. 4. RAILWAY BRIDGE OVER RAVINE.

FIG. 5. CANTILEVER BRIDGE OVER DEEP VALLEY.

Fig. 1. Point A. Section of Post.

Fig. 2. Connections in Top and Bott. Chord.

Fig. 3. Detail of Point X.

Fig. 4. Detail of Point M.

Fig. 5. Detail of Point K in Pier.

DIAGRAMS SHOWING APPLICATION OF SKEW PIN CONNECTIONS.

The Burnett & Clifton Automatic Coal Chute.

(WITH INSET).

We illustrate this week a form of coal pocket for coaling locomotives which has come into extensive use on the Chicago, Rock Island & Pacific, the Union Pacific, the Chicago, Burlington & Quincy and many other prominent Western roads. It is well known that locomotives can be coaled from elevated pockets with less delay than by any other method; and where any considerable number of locomotives are to be supplied with fuel, the use of pockets is generally admitted to be advisable and economical.

In the construction of a system of pockets the important things to be looked after are strength, durability and reliability. The dumping of the coal into the pocket from a considerable height causes a good deal of shock and wear; and this, with the dirt and dust, is likely to cause any complicated mechanism to get out of order. It is necessary, however, to have the system of opening and closing the pocket so arranged that it can be easily and quickly worked; for if delay is caused, the advantage gained by the use of pockets is partially lost.

It is excellent evidence that the system of pocket construction illustrated on our inset sheet does meet the requirements stated above that its use has rapidly increased on the progressive railways of the West, and last year over 1,200 pockets were built on this system.

In general a coal pocket consists of an elevated bin having an inclined floor, the front of the bin being a hinged door opening outward, which is unfastened when it is desired to draw coal from the pocket. To direct the stream of coal so that it will fall in the middle of the tender, an apron or chute is used, over which the coal runs as it leaves the pocket. In the best designs this apron is hinged, and when not in use it swings up to a vertical position covering the door and effectually looking it.

In the accompanying drawings all the details of the construction of the Burnett & Clifton chute are clearly shown. The apron of the chute is balanced by arms extending to the rear and carrying an iron weight at the end. Thus the apron is balanced in any position and without the use of the chains and pulleys by which balancing is often effected. The counterweight is made slightly heavier than the apron, hence as soon as the coal has run out of the pocket the apron automatically swings up to the vertical position. The apron is made of white oak and put together with bolts. A 2-in. steel channel is used to cover the top of the arms and prevent warping. When swung up to the vertical position, the apron latches automatically.

The inner door, which retains the coal in the pocket, is also made of oak. It is latched and unlatched by the movement of the apron. Moreover, when the door is opened it is held open by an automatic latch until the coal has all run out of the pocket, then as the apron swings up the door is released, falls back into place and is automatically fastened shut by the apron's movement. The holding open of the door while the coal is running prevents the stoppage of slack and dust by the premature closing of the door. The floor of the pocket is covered with No. 12 sheet steel and is built for bituminous coal at an angle of 35° with the horizontal. Anthracite would probably slide on a somewhat flatter angle. Some roads cover the surface of the apron also with sheet steel, but this is unnecessary. The friction of motion being less than that of rest, all the coal which starts out of the pocket will slide off the apron.

In using coal pockets the general practice is to fill them with varying amounts of coal. When a locomotive approaches, the engineer gives a series of whistles to inform the men in charge how many tons of coal he wishes. In response a red lantern or red flag is displayed over the pocket containing the desired quantity.

A plan for making a single pocket do for two charges of coal is shown in one of the drawings of our inset sheet. A swinging partition is placed in the pocket. When this is latched down, the coal on the front side can be taken and that on the rear held. Then by unlatching the door the rest of the coal can be drawn. This, however, involves more or less complication in the construction of the pocket, and its use is not increasing.

Messrs. BURNETT and CLIFTON, the inventors of this chute, have disposed of their patents to Messrs. Williams, White & Co., of Moline, Ill., who formerly made the ironwork for the patentees, and who now offer the chute for railway use.

To railways desiring to build their own chutes hey offer to furnish the special irons required,

with license to construct as many pockets as irons are purchased for. They state that the price asked for the irons is little more than what they would cost if made in the railway company's shops. If desired they will furnish also all the iron work required, including bolts, or will contract for the building of the whole structure complete.

A chute built on this system has been in use for some time on the Delaware & Hudson Canal Co.'s R. R. at Mohawk, N. Y., and is stated by Chief Engineer A. J. SWIFT to be giving the best satisfaction.

The Laying Out of Cities and Additions Thereto.

Mr. J. J. DONOVAN, M. Am. Soc. C. E., has recently prepared and submitted to Mr. C. X. LARRABEE, President of the Fairhaven Land Co., of Fairhaven, Wash., the following report on the laying out of cities, which makes some very sound recommendations. Fairhaven, as most of our readers know, is a rising young city on Bellingham Bay, Puget Sound, which has been growing very rapidly recently, and bids fair to become a worthy rival of Tacoma or Seattle, while it treasures a modest hope of outdoing both of them:

Gen. Q. A. GILLMORE, in his work on roads, streets and pavements, says: "A street in a city or town where the best ordered modern devices for promoting the comfort, convenience and health of the inhabitants have been introduced, should provide upon and beneath the surface (1) for the accommodation of ordinary travel and traffic, (2) for the drainage of the surface and subsoil, (3) for conveying away the fecal and liquid refuse called sewage, and (4) for conducting water and gas to the inhabitants.'

Any street now dedicated in Fairhaven will, if properly graded, fulfill the last three requirements, but " for the accommodation of ordinary travel and traffic" there is need of careful consideration before determining the number, width or direction of the new streets on any given piece of property. While in the East this season I endeavored to obtain such information as I conveniently could on this subject and gave special attention to sizes of blocks, alleys, width of streets and regularity of plotting.

Among the cities where I spent from one day to several weeks were Winnipeg and Montreal, in Canada; Somerville, Worcester and Boston, Mass.; Manchester and Concord, N. H.; New York and Jersey City, and Washington, D. C.

Herewith I hand you maps of most of these cities which will of themselves answer many questions that arise regarding the manner of plotting. None of these cities maintain rectangular blocks throughout, and where grades were steep streets are bent or curved wherever necessary for betterment. In many of the cities I found diagonal streets laid between important points in order to secure the shortest possible route, without other topographical reason. This is especially true at Washington, D. C. Every engineer and person with whom I talked on the subject in the East favored alleys provided they ran clear through the blocks and were not "blind." Widths generally considered best were 16 to 20 ft. I found alleys in the older cities not over 6 ft. wide, and even Washington has some 10-ft. alleys, though usually 20 ft. This latter width is also the most common in the newer parts of Boston and Manchester. In New York City the limited area and high price of land has prevented the laying out of alleys and there are few if any in the city.

Sizes of blocks vary much in every city. Glancing over the maps you will find very few blocks as small as those in the original Fairhaven townsite, *i. e.*, 200 ft. square. Typical blocks in following cities are sizes given:

Manchester, 200 by 450.

Montreal, 250 by 750.

New York, 200 by 900 and 200 by 400.

Boston, 220 by 400 and 100 by 550.

Washington, 400 by 600 and 300 by 800, with nearly all above sizes besides. Blocks over 270 ft. wide are objectionable because of small, unsightly buildings which are often built in their interior fronting on alleys and because of difficulty in keeping in good sanitary condition.

Lots vary nearly as much as blocks, ranging from 16 to 50 ft. in width and from 100 to 180 ft. in depth. It seems desirable to divide blocks into lots of such size that few of the lots shall be sub-divided in the future, as clearness of identity is maintained by always referring to the original number for transfer or assessment purposes. Many lots in Manchester, Boston, New York and Washington are only 18 or 20 ft. wide; but 25 ft. is common and is almost universal in the newer western cities, with depths from 100 in business to 125 or 135 for residence property. Twenty-five feet frontage seems best for business, and where residences are to be built two or more 25 ft. lots give proper grounds.

Width of streets varies greatly. The great avenues of Washington are 160 ft. wide. Those of New York City and of Winnipeg are 135. I have not the figures for Boston's beautiful Commonwealth Ave., but it is probably 180 ft. between the building lines. Buildings are kept back about 20 ft. from the front of the lots, this space being used for lawn and flowers, then sidewalk, roadway and strip of park, with footway down the center, makes an ideal residence street. The parking system is followed on all eastern residence streets, and the first cost is little, if any, greater than our present system, while the result is much more satisfactory. With 80-ft. streets, 8 ft. of sidewalk, 14 ft. of grass and trees on each side and 33 ft. of roadway combine beauty with ample utility.

Proper width of streets will, of course, depend on the probable future of a city. Manchester, N. H., a modern manufacturing town with 40,000 people, gets on very well with a main business street 120 ft. wide, and cross streets only 50 ft., yet with treble that population business would undoubtedly be greatly congested. No business street should be less than 80 ft., or residence less than 60 ft. wide, while most important streets of either class may be nearly double these widths when circumstances seem to justify. In a recent article on this subject in ENGINEERING NEWS, Mr. N. H. DORSEY recommends for the average young city: "Blocks, 220 by 400, with 20-ft. alleys bounded by 70 and 80-ft. avenues on the long side and 60 to 66-ft. streets on the short sides." With blocks 250 by 400 in residence streets, and wider streets in central part of towns that promise to become large cities, Mr. DORSEY'S rule is probably as good as any which must necessarily vary with local circumstances.

At Fairhaven the question of easy grades is most important to consider, and new streets should be laid with this in view, rather than securing rectangular blocks, for these blocks will be of little value even for residences if approached by grades of over 10%. While steep grades in portions of the city cannot be wholly avoided, there is no reason why on any given tract diagonal avenues should not give approach to the hill streets on grades not to exceed 10%, and preferably kept between 5% and 7%. The use made of such avenues in Tacoma, and the inconvenience of their absence in Seattle, is sufficient illustration of their need.

The importance of avoiding hills, or, at least, steep grades, will be made clear by a few citations [omitted]. When road is soft or muddy the difference in resistance is much greater, and makes a worse showing for the heavy grades. So important is this considered that the famous Simplon Pass road over the Alps has a grade of only 1 in 17 in Switzerland and 1 in 22 on the Italian side. The French government maximum is 1 in 20. GILMORE says a horse can draw up a 5% grade, unless it be a very long slope, his ordinary load for a level road, without the help of a second animal. To avoid hills, Prof. JOHN V. HAZEN in a prize essay on road making, says, " Within proper limits a road may wisely be increased in length by 15 times the vertical height avoided by the detour."

A recent number of ENGINEERING NEWS (Oct. 10, 1891) in an admirable article speaking of a proposition to cut a diagonal boulevard 150 ft. wide and a mile long through a portion of Philadelphia at a cost of $3,000,000, counts the cost as nominal compared with the benefits to be derived, and goes on to say:

> The rectangular formation of streets is well enough for a beginning, and is, perhaps, the best for the settlement and original apportionment of property. It has its marked advantages in the systematic numbering of houses, naming of streets and disposition of certain classes of pipes under the streets; and in the early stages of municipal development the distance between given points is not a question of any special importance. But as a city grows in area, the gridiron plan more and more fails to meet the requirements of rapid traffic and the want of diagonal streets is more keenly felt.
>
> The City of Washington is a notable exception of a city well planned before the building was commenced and in which some thought was taken of the demands and convenience of a population yet to come. In this city, while the general plan for the smaller streets is rectangular, these streets are intersected by a primary system of wide diagonal streets radiating from fixed centers. The resultant effect is, a number of handsome smaller parks, a very marked improvement in the appearance of the city, and above all, streets which lead in the direction of main threads of travel, which usually radiate from centers of business to the residence portion of the city.
>
> The advantages to be gained from a well studied and intelligent departure from the rectangular street formation may be stated as follows: First, ease and directness of access to points remote from a business center and situated diagonally as regards that center and a rectangular block system. Valuable time is lost and business made to suffer by forcing traffic to take two sides of a right-angled triangle when the hypotenuse could be opened to it. Then bordering property is improved and not destroyed, as some would believe, by making it easier of access and placing it on a thoroughfare that is soon to attract traffic and trade. And, finally, every expenditure that enhances the beauty of a city and makes it more attractive to the resident and the stranger is a solid investment that can be measured by cash returns. The present beauty of Paris, a beauty that is recognized by all nations and attracts the traveler and his dollars, is practically due to its wide, tree-planted boulevards, its fine public and private buildings that are displayed to the best advantage, and to the studied irregularity of its streets. A clump of trees, a small park, a group of statuary or even a simple patch of green grass at the intersection of streets, is worth all the money it costs, and is worth much more to the whole community than the mere space for brick and mortar which it supplants."

In all my eastern trips nothing impressed me more as making cities attractive than the numerous small parks of Washington and those of New York and Boston as well as those of many New England towns. With more attention to diagonal streets and easy grades, and with occasional parks much improvement can be made over the ordinary manner of plotting towns and additions thereto. Too much space devoted to streets, or too frequent streets, is a common mistake that causes useless expenditure for construction and maintenance.

No inflexible rule can be made, but it is believed that work planned in accordance with the general ideas herein outlined with minor local variations will give satisfactory results both to original owners and purchasers of property.

The Steel Skeleton Type of High Buildings.

III.

(*Continued from page 561.*)

The question of unit strains is very closely allied to that of loads, and Chicago practice in regard to this varies a great deal. In this building, columns without strains from wind bracing are given 1 sq. in. of section for every 15,000 lbs. of concentric dead and live load, and an extra allowance for eccentric loads, which is determined as follows:

The eccentric load × distance from the point of its application to the axis of the column = the bending moment. The moment of inertia required to make an equivalent resisting moment in the column is then determined the same as if the column were a built up beam. The moment of inertia in a column capable of carrying the concentric load alone is also determined, and a column is finally taken whose moments of inertia is equal to the sum of the two. It is surprising to note the effects of these eccentric loads when their relation to the column is carefully examined, and in many cases they materially increase the required section.

Columns carrying strains from wind bracing are given 1 sq. in. of section for every 20,000 lbs. of concentric, dead, live and wind loads combined, with an additional allowance for the eccentric loading. In these the column strain due to wind forces is from 35 to 40% of the whole load, and this mode of treatment gives a much greater section to the column than if the wind load were discarded and the columns were treated as if there were no wind strains in them. In any case the method that can give the larger section should always be used. It will be noted by reference to the schedule that a considerable portion of this wind load is eccentric. This must be the case where the method of bracing which is adopted for the Venetian Building is used.

These unit strains are quite common and have been used in a number of our best buildings. If 15,000 lbs. per sq. in. is used it ought always to be done with a proper allowance for the eccentric loads, as was done in the example given. Great care should also be used in regard to every point that will better fit the column to bear its load. If these things are not done a lighter unit strain should be used. This has been done in the Fair, where 12,000 lbs. unit strain has been used uniformly and with no allowance for eccentric loading. This is probably the strongest building of the kind in the world. The first, second, third, fourth and sixth floors are made to carry 130 lbs. per sq. ft. of live load, the fifth floor to carry 200 lbs., the seventh and eighth floors to carry 100 lbs., and the other eight floors each to carry 75 lbs., all this, of course, in addition to the dead loads. Every precaution has been used to secure good connections and a perfect distribution of loads. All the sections are necessarily heavy and the construction as a whole is extremely strong and massive.

This way of dimensioning columns has grown out of practical experiences. In the rush of affairs there is little time for experiments. The only full sized tests that have been made in Z-bar columns, of any moment, are those described in a paper on Z-bar columns by Mr. C. L. STROBEL (Trans. Am. Soc. C. E., April, 1888), to whom we are indebted for its introduction into this country.

But these tests were hardly fair ones, for latticed bars were used instead of a web plate, the metal was iron instead of steel, and almost all of the tests were for a much higher ratio of radius of gyration to length of column than is met with in building construction. If another similar series of tests could be made on columns as we are using them, it seems very reasonable to suppose that higher breaking loads would be obtained than were recorded at that time.

The largest section of a Z-bar column now in use in Chicago, so far as the writer is informed, is in the Fair building. The total area is 142 sq. ins., made up as follows:

4 Z-bars 6 × ⅜ in.
2 web plates 16 × ¾ in.
6 cover plates 16 × $\frac{13}{16}$ in.

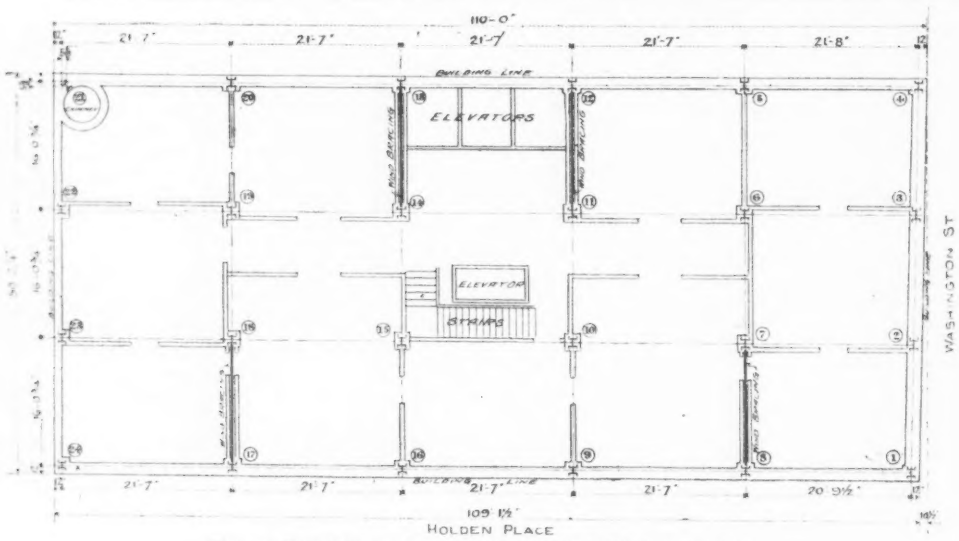


FIG. 2. TYPICAL FLOOR PLAN OF VENETIAN BUILDING

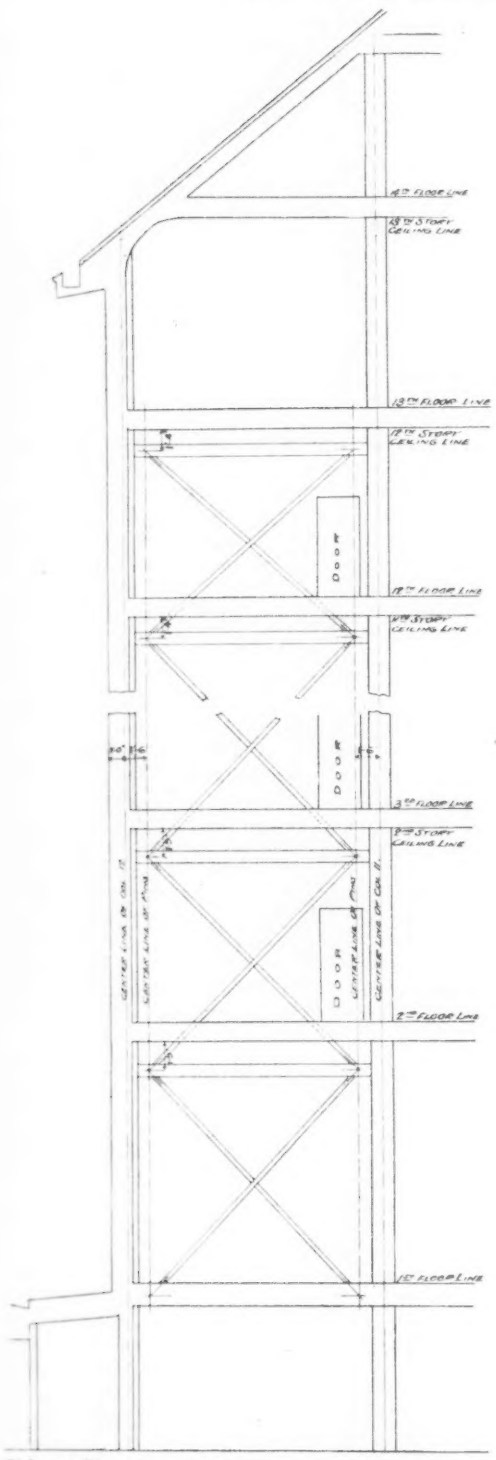


FIG. 3. Elevation of Wind Bracing Between Columns 11 and 12, Venetian Building

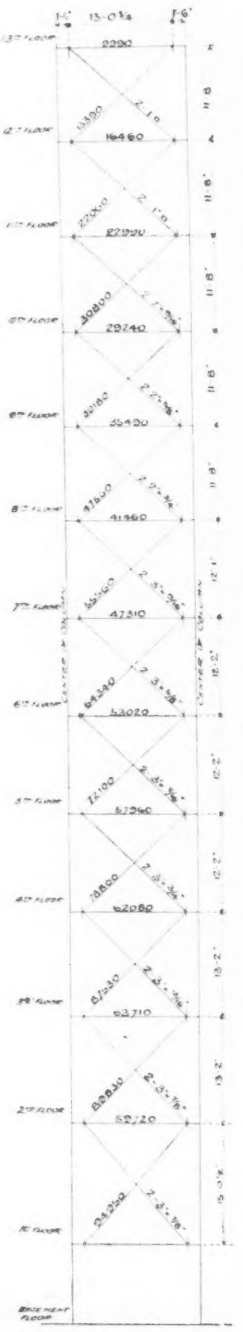


FIG. 4. Wind Strains in Venetian Building.

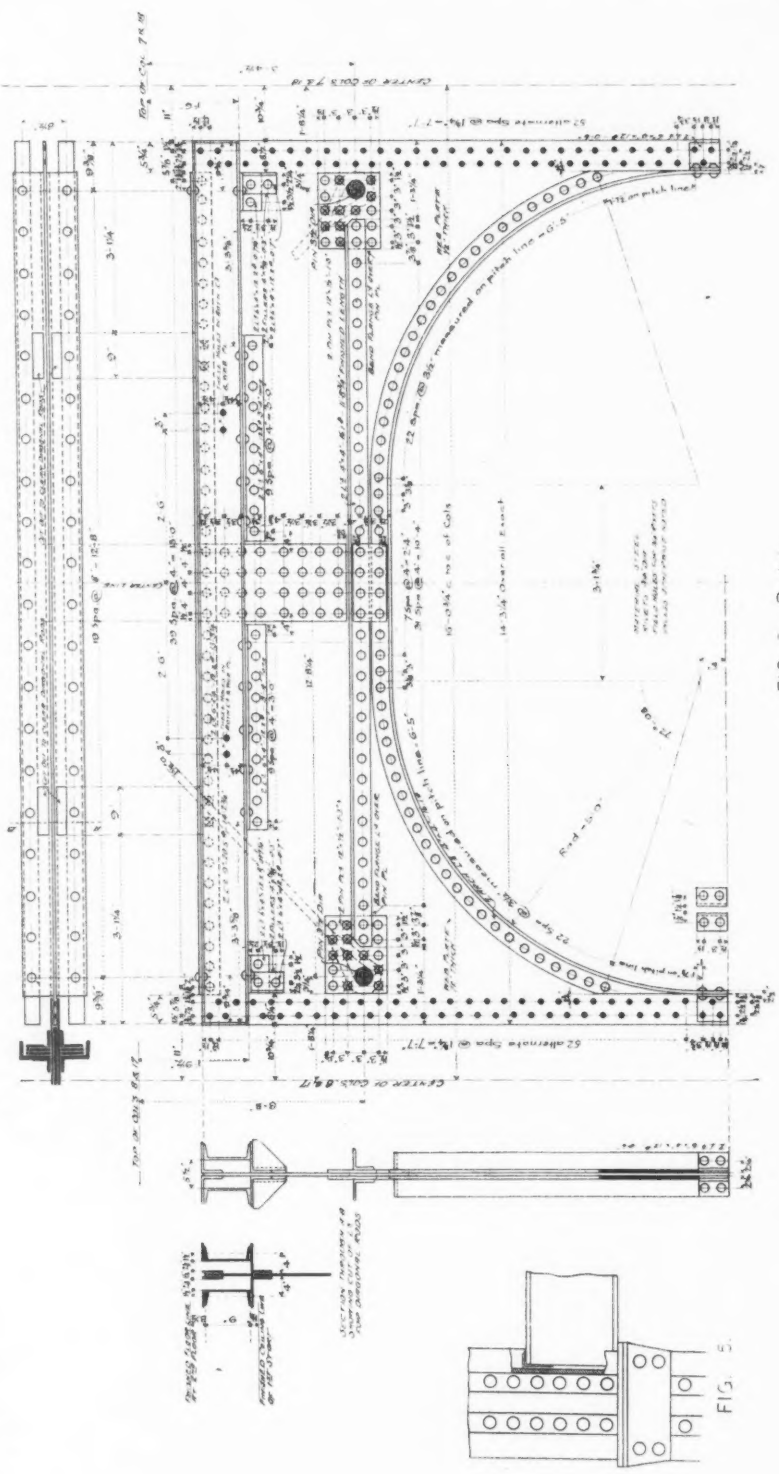


FIG. 5. Portal.

and it will carry a load when the building is completed of about 1,700,000 lbs. The minimum section generally used has 12.4 sq. ins. and is made up of

4 Z-bars 3 × $\frac{5}{16}$ in. and
1 web plate 8 × $\frac{5}{16}$ in.

In the best practice no metal less than $\frac{5}{8}$ in. in thickness is used. In some construction the minimum column is made even larger than this. Generally columns are cut off at the bottom of the floor beams and capped with a $\frac{3}{4}$-in. plate, but occasionally columns have to be made extending continuously through two floors.

In the Masonic Temple, the engineers have made all the columns two stories long and then by a very ingenious arrangement have alternated them so that most of the beams between columns connect to the middle of one column and rest on the top of the other. There is no question but that this arrangement must add stiffness to the structure and be an additional factor of safety to the building.

The general practice is to connect all beams to the columns by rivets through both the top and bottom flanges. The rivets through the bottom flanges should pass through the cap plate and through an angle riveted to the bottom column. In some cases the bottom connection has been made to the cap plate only. Such a connection should be avoided, as the lateral strain which must be resisted should go to the column and not to the cap plate. In ordinary practice there would hardly be room to connect the cap plate to either column sufficiently to warrant its use as a lug.

The columns should be connected to each other by

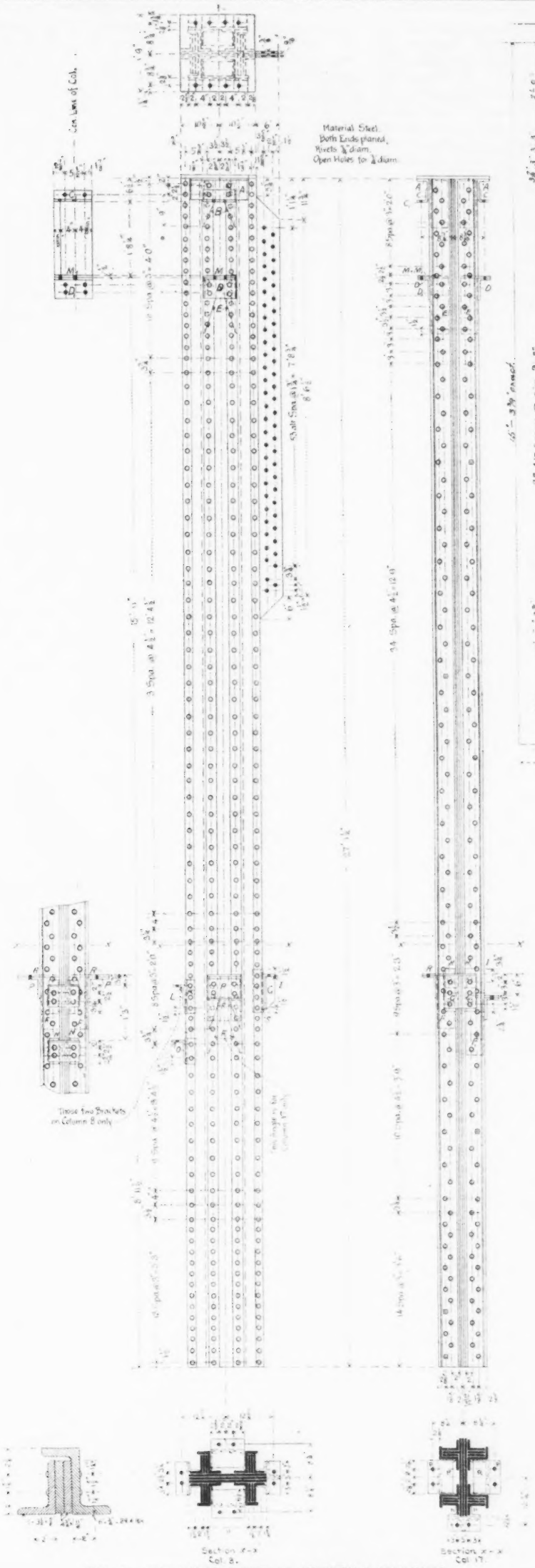

Material Steel.
Both Ends planed.
Rivets ⅞" diam.
Open Holes for ⅞ diam.
Those two Brackets on Column 8 only.
Section X-X Col. 8.
Section X-X Col. 17.

FIG. 5. COLUMNS 8 AND 17, VENETIAN BUILDING.

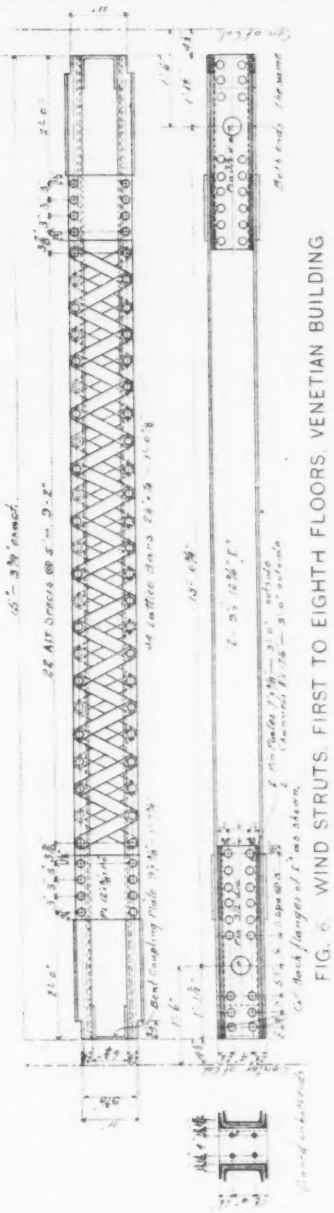


FIG. 6. WIND STRUTS, FIRST TO EIGHTH FLOORS, VENETIAN BUILDING.

at least 4 rivets spaced on opposite sides and as far as possible from the center of the column, and passing through the cap plate and connecting angles on each column. If this course is followed, every rivet that is driven tends to stiffen the connection of the two columns to each other. If the loads from the beams are heavy, bracket angles should be provided in the lower column to take part of the shear off the cap plate. It is the custom to give not less than 3½ lin. in. of actual bearing to each beam. All columns should be carefully planed on the ends, smoothly and at right angles to the axis of the column.

Wind bracing has already been referred to. It is important that extremely high buildings should be well braced against wind forces. In ordinary buildings dependence is had upon partitions and walls, but the moment arising from the force of wind tending to distort the building grows rapidly greater in very high buildings, especially if they are narrow. In such cases it seems necessary to resist this action by steel built bracing, and the higher the building, the greater the necessity.

When this is done, especial consideration should be given the subject in the designing of the building. When it has not had such consideration any really efficient bracing is almost certain to interfere with the architectural effect or the arrangement of the rooms. At least it is a difficult problem, and failures to make any system that may be adopted complete in all its parts, or to provide proper connections may easily make what is done useless.

The Venetian Building, which has already been referred to, is probably as well braced as any building in the city. Fig. 2 is a small diagram of a floor of this building, showing the arrangement of the

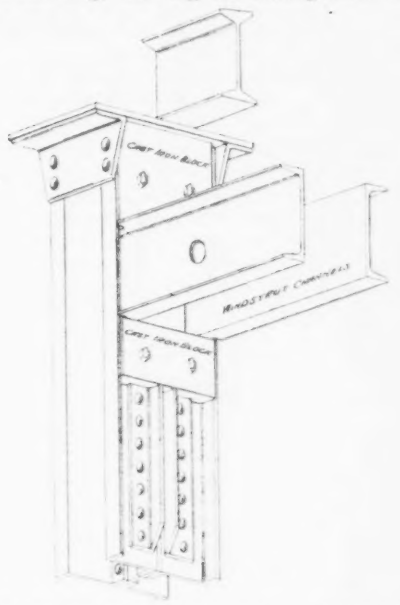


Fig. 6. Sketch Showing Connection of Wind Struts and Columns.

columns and the position of the bracing in plan. Fig. 3 shows the position of struts and diagonals between columns 12 and 12 in the elevation. The area between columns 7 and 8 and 17 and 18 of the first floor being a part of a store, the diagonal rods between the first and second floors are omitted and portals are substituted in their place.

Fig. 4 is a strain sheet for this wind bracing, excepting only the column strains, which have been included in the schedule already given. There is no uniformity, as far as the writer knows, in regard to the calculations of wind strains. The conditions vary greatly in different buildings. In every case a great deal must depend upon the judgment of the engineer, and the opinions of the engineers have differed as widely as the conditions.

The calculations of the strains given above were made as follows: Each set of bracing was figured to resist the wind force for a tributary area, the horizontal width of which is equal to one-fifth the length of the building. The area of the height tributary to each floor × 40 lbs. = the horizontal shear acting directly on each set of diagonal rods. The total shear at any of these points, that is, at any floor level, is

BILL OF MATERIAL FOR CONSTRUCTING COLUMNS 8 AND 17. (FIG. 5.)

No. Pcs.	Mark.	Description.	Section.			Length.	
			ins.	ins.	lbs.	ft.	ins
4	.....	Web plates..	27	⅜		27	1½
2	.....	" "	21	"		27	1¼
8	.....	Z bars.....		6	29.3	27	1¼
8	.....	Angles.....	5	3½	17.2	27	1¼
16	.....	Bars.....	4¾	½	"	27	1¼
2	.....	Cap plates.....	21	¾		1	9
4	A	Conn. angles....	6	3½	15.3	1	4
8	B	" "	5	3½	"	1	1⅛
3	C	" "	4	3	8.6		9¾
1	C_1	" "	4	3	8.6		10¼
3	D	Bracket Angle..	6	3½	15.3		9¾
1	D_1	" " ..	6	3½	15.3		10¼
4	E	" " ..	5	3½	13.5	1	4¾
6	F	" "	5	3½	13.5	1	3¾
2	F_1	" "	5	3½	13.5	1	4¾
4	G	Stiff angles.....	4½	3	9.1		9½
4	H	Bracket angle..	3	3	7.1	1	
2	I	" " ..	4	3	8.6		9
2	K	" "	3	3	7.1		9
1	L	" "	6	4	14.3		9
4	R	Bearing plate...	9¼	½			8
2	N	Bracket angle..	3	3	7.1		7½
1	O	" "	6	4	14.3		9
3	M	Bearing plate...	9¼	½			8
1	M_1	" " ...	10¼	½			8
4	P	Bracket angle..	6	3½	15.3		9¼
2	S	Filler plate.....	6	⅜			9

equal to the sum of the shears acting directly on the points above it. It has not been deemed necessary, however, to carry the whole amount of this shear into the steel bracing. In any building the dead weight of the structure itself acts to some extent to counteract the distorting effect due to a lateral force. These shears might certainly be reduced to some extent on this account, and they have been so reduced. The steel bracing then is made to resist 70% of the remainder, leaving 30% to be cared for by the partitions.

The riveting of column to column and beam to column of course tends to some extent to stiffen a building, but a careful analysis of the problem will show that it is not enough to depend upon to any appreciable extent in resisting such a lateral strain as 40 lbs. per sq. ft.

All the columns affected by this bracing have been made continuous from the basement to the second floor. In the cases where the rods come down to the first floor level the bottom strut is connected to the columns so as to take both tension and compression horizontally, as well as to resist the vertical component of the rod strain. This insures the resistance of both columns to the horizontal thrust of the strut, whichever pair of rods is strained, and the columns are calculated to resist the bending moment incurred, as well as to carry its regular column loads. In the other cases, the columns have been especially designed to resist the tremendous bending moment which the cutting off of the rods necessitates, and as an additional assurance that this connection shall be as strong as the rest of the system, the top connections of all of the beams of the first floor are omitted and the clearance space between the ends of all the beams and the columns are driven tight with thin wedges until the lines of metal passing through the column centers are continuously in compression out to the area walls, which latter are backed by the street pavements. In Fig. 5 the drawings of these parts are reproduced directly from the shop drawings. The horizontal struts are made of the same size up to the seventh story, and above this a lighter section is used.

Fig. 6 shows one of these struts, also taken from the shop drawing, with a sketch picturing its connection to the column. It will be noticed that there is but slight connection of the strut to the column. The struts are planed at both ends and no clearance is allowed for connections so that the struts have butting joints to the column. Open holes are provided for four rivets connecting the column, but these are hardly necessary. Underneath the end of the strut is a solid cast iron block and underneath the block are two bracket angles secured to the column with sufficient rivet area to resist the vertical component of the rods in this direction. Above the end of the strut is another cast-iron block planed on top and bottom to fit in tightly between the strut and the cap plate of the column. This block is made to fit the recess made by the flanges of the Z-bars so closely that the ¾-in. cap plate is brought into direct shear entirely around three sides of the block. The shear resistance of the plate, together with the weight of the beam directly upon it, are more than enough to resist the upward vertical component of the rods. The use of cast blocks in this connection has been found very convenient, for it often occurs that the bracket angles cannot be brought directly under the channels of the strut, and the medium between the strut and the bracket angles must act as a beam as well as a filler.

The query may well arise why the pin points are taken so far from the column, and why the struts are not all placed in the floor. Both are for the same reason; they are part of the general scheme to put up the bracing without obstructing the door ways. This gives some intimation of the sort of difficulties that the engineer has to labor with in the construction of steel buildings.

It will be noticed that the struts are re-enforced at the pin points to resisting the bending moment of the strut caused by moving the pin center so far from the center of the column. The diagonal rods are all dimensioned for 20,000 lbs. unit strain, and no rod is less than ⅞ in. square. All these rods are provided with turn-buckles.

In the Ashland Block, a 16-story building now being erected, these struts are longer and are made of 15-in. channels, placed in the floors and made to do duty as floor beams.

The whole subject of columns, as it applies to building construction, is exceedingly interesting and involves more questions, both practical and theoretical, than most men realize. It would be a great advantage to all concerned if we could have a series of extended experiments on full sized members, not only for the ultimate strength, &c., of all sections on the same basis, but also for the effects of eccentric loading and of various applications of loads.

(To be continued.)

A Trip to Chicago and Cleveland.

On the occasion of a recent trip to Chicago to investigate the condition of the work on the World's Columbian Exposition, the route taken was over the New York, Lake Erie & Western R. R., which by its ownership of the New York, Pennsylvania & Ohio R. R. and the Chicago & Erie R. R., has a line of its own between New York and Chicago. This road runs a through train from New York (Jersey City station) which is very convenient, although its time is nearly 30 hours. The train leaves Jersey City at 3:15 P. M. and is due at Chicago, 982 miles, at 8:50 P. M. the next day. On this trip the train consisted of a baggage and smoking car, day passenger car, dining car and three vestibuled Pullman sleeping cars, the two rear cars being cut off to run through to other points. The engine was one of the new ten-wheel, four-cylinder Vauclain compound engines, built by the Baldwin Locomotive Works, of Philadelphia, Pa. (ENGINEERING NEWS, Sept. 5, 1891.) Tests were being made with this engine, and indicator cards were taken during the run to Port Jervis but one long stop was made owing to the heating of some part of the machinery. A considerable portion of the main line of the N. Y., L. E. & W. R. R. is laid with 80-lb. rails, laid with three-tie joints and spliced by 40-in. angle bars with 6 bolts, and is also equipped with the block signal system. On the western part of the line, particularly on the Chicago & Erie, the track causes considerable jolting and jarring of the cars. This train has a through dining car, which is a very convenient and pleasant arrangement. The Pullman cars are comfortable and handsomely equipped, but are kept at an unpleasantly high temperature during the day. At night, however, the steam heat is shut off. The train was 15 minutes late on its arrival at Chicago.

The main business portion of the city of Chicago is comprised within a comparatively small district, divided into nearly square blocks. It is noted for its large and high office buildings, many of which are very elaborate. The highest range from 10 and 12 to 21 stories, the latter being the height of the new Masonic Temple, while a permit is said to have been granted for an Odd Fellows' building 32 stories high. A movement is now on foot to limit the height of buildings, for sanitary and other reasons. Particulars of the construction of some of these buildings have been published in our columns. Very great attention is paid to lightening the weight without reducing the strength, and to the distribution of the weight, so that some of these buildings put no greater weight on the foundations than older 6 and 7-story buildings. In one of the new buildings the tile partitions weigh 27 lbs. per sq.. ft., while in a still later building this has been reduced to 15 lbs., with, it is claimed, equal strength and fire resisting capacity. As a general thing the highest buildings do not appear to advantage, owing to the comparative narrowness of the streets. Large numbers of elevators are used, some running only half way up, and the others stopping only at the upper floors.

The street paving is far from satisfactory, and the mayor has recently done a wise thing in advising prompt steps for improvement, in view of the Exposition. Round cedar blocks are extensively used. In wet weather the mud is worse than in New York. The sidewalks are generally good, but the city has much to do in street improvement and street lighting before it can be considered as up to modern standards. The fuel used is almost exclusively soft coal, and the appearance of the city is spoiled by the dense clouds of black smoke which pour out from innumerable chimneys, and in bad weather this smoke seems to fill the streets. The smoke-consuming ordinance appears to be practically a dead letter, and the work of the inspectors acting under this ordinance of very little effect. For its own credit the city should take some active measures to abate this smoke nuisance before the time of the Exposition, and the question of its abatement is again being agitated. It is almost certain that while the use of efficient smoke-consumers and special appliances for the general improvement of combustion may be desirable with the grade of coal used in Chicago, a very considerable improvement can be made by the use of modern grates and furnace arrangements, and by careful firing, involving the employment of skilled firemen instead of mere coal shovelers.

The forked Chicago River, which divides the city into the South, West and North sides, is crossed by numerous iron drawbridges, most of them operated by steam from a cabin above the trusses. Some of these swing right round. Navigation on the narrow and dirty river is carried on throughout the day, thus seriously interfering with street traffic, and being "bridged" is an exasperating but frequent occurrence. There are two tunnels, but these are used almost exclusively by the cable railways, few vehicles running the chance of being smashed by a cable train. Collisions of trains occur occasionally in the tunnels, owing to the failure of grips or brakes on the approaches. The La Salle St. tunnel has a separate passage for pedestrians. The tunnels are lighted by electricity. A third tunnel for cable railway only is about half completed. It was described and illustrated in ENGINEERING NEWS, Feb. 22, 1890. Mr. S. G. ARTINGSTALL is the Chief Engineer, and Mr. C. V. WESTON, the Engineer in Charge. A tunnel for roadway and sidewalks only is proposed between the North and South sides, and plans for this have been prepared by Gen. SOOY SMITH.

A considerable mileage of the street railway system is operated by cable traction, which works very satisfactorily, but on some of the lines there is much noise and vibration in the cars, and the gripmen are not careful to stop and start with an even motion. Short open grip cars, with box trail cars, are used; also long cars on four-wheel trucks, the forward section of the car, where the gripman stands, being open. Wire gates shut off the steps on the off side of the cars, and guards are placed around the wheels and grip. In some cases as many as 3 trail cars are attached to the short grip cars. Along one side of the alley between State St. and Wabash Ave. runs the Chicago & South Side Elevated Ry., which is practically completed from 12th to 39th Sts. Work is progressing northward to Congress St., and the line is to be extended to Jackson Park by 1893. We are indebted to Mr. R. I. SLOAN, Chief Engineer, for drawings of this structure, which we shall publish later. A part of another elevated railway has been built on Lake St., on the West side, and it is said that construction is to be resumed shortly.

The drainage canal question continues to be a vexed one. A route has been adopted for a canal from the Chicago River to Joliet, 180 ft. wide at bottom and 18 ft. deep in rock; and 160 ft. wide and 14 ft. deep in clay. Some of the trustees claim that this has been adopted without sufficient investigation, and that no detailed report of the details of the reasons upon which it was adopted has been submitted. The Chief Engineer, Mr. ARTINGSTALL, has been instructed to report upon this point, showing all the information thus far obtained. The adopted plans show the water descending over a series of dams at the lower end of the canal, but a number of the trustees and of the citizens are in favor of the adoption from the first of a deep water ship canal. Mr. F. WENTER, one of these trustees, has recently been elected President of the board, and Mr. L. E. COOLEY, formerly Chief Engineer, and also in favor of a ship canal, is now one of the trustees.

Chicago is the centering point of a large number of railways, about 25 lines running into the city, being accommodated by 7 stations. The worst station is that of the Illinois Central R. R., a dilapidated structure which has not been rebuilt since the great fire in 1871. Among the finest is the new Grand Central station, of the Wisconsin Central and other lines. The railways enter the city on the level, and there is much valuable ground occupied by tracks and yards, while the Illinois Central R. R. has possession of the lake front for a long distance. In some cases the tracks are crossed by bridges and viaducts, but probably many of the roads will eventually have to build elevated approaches to the terminal stations. This matter is already under

consideration by some of the railways, as noted in our pages last week.

The following are some notes obtained from manufacturing firms, but few firms are ready to say what they will do in the way of exhibits at the Exposition:

Illinois Steel Co.—Orders for rails are mostly for light sections, but the company has rolled the 90-lb. rails for the Chicago & South Side Elevated Ry., the section of which is similar to that adopted for the New York elevated railway.

Harvey Steel Car Co.—The company has built a number of its cars, of different types, for various roads, and is now building for the Chicago, Milwaukee & St. Paul R. R. 10 stock cars of the type illustrated in ENGINEERING NEWS, July 11, 1891.

Binder & Seifert.—This firm has the contract for the metal work of Machinery Hall and for the dome of the Horticultural Building at the Exposition. We shall publish drawings of this work later.

Pneumatic Gate Co.—This company manufactures gates for the protection of grade crossings. They have pivoted arms moving vertically and are operated by compressed air, the compressing pump being worked by the gateman. The company does not approve of automatic gates, on the ground that such gates are more liable to lead to accidents than gates operated by a man, who can exercise judgment in their working.

Hutchinson Water Gas Furnace Co.—Mr. HUTCHINSON reports that he has his device fitted to 1,500 locomotives and about 4,800 stationary furnaces. The apparatus consists of steam jets, injected into the firebox through hollow stay bolts. The effect of this is said to be not only the aid due to the jet, but to create a water gas in the firebox. The apparatus has been in operation about eight years.

The Q. & C. Co.—The Servis tie-plate is said to be finding increased favor among railways as an efficient substitute for rail braces. The Denver & Rio Grande R. R. has used some of the wide plates with four spikes on curves on the widened gauge, and finds them more economical than braces in maintenance of gage. For oak ties the company recommends the narrower plates. An improved form of the Davies spike is now being tested on the New York Central R. R. and the Pennsylvania R. R.

From Chicago to Cleveland the route taken was over the Lake Shore & Michigan Southern Ry. The train was the New York "fast mail," which averaged 8 to 10 minutes late at its several stops. The line is single track for the most part, but there is considerable fencing in and grading, and some tracklaying, in progress for double tracking. Like nearly all the railways to Chicago, this road will have to do a large amount of work to make it capable of accommodating the heavy traffic in connection with the World's Fair in 1893.

The city of Cleveland appears quite hilly by contrast with the flatness of Chicago. The business section and outlying residence districts are mainly on high ground, while the manufacturing districts lie in the valleys along the river and on the low ground. Some viaducts have been built to connect the high ground on both sides of the river, and these are among the specially interesting features of the city. Some are of iron deck truss work, while the Superior St. viaduct has stone masonry approaches, with iron deck shore spans and a high-level deck draw span. The business streets are generally wide, and have some fine buildings. Euclid Ave. is a thoroughfare of which the city is justly proud. On each side of the well paved roadway is a broad strip of grass, lined with trees; then comes a flag sidewalk, from which the lawns slope back to handsome residences. The street is lighted by arc lamps hung over the middle of the roadway, and an electric railway runs on a part of the street.

The city is well provided with electric, cable and horse railways, and some of the latter will soon be changed to the electric system. The cable railways are operated by short, four-wheel, open grip cars, with sometimes one four-wheel trail car. The electric railways aggregate about 100 miles, all with overhead wires, and are on the Short, Edison and Thomson-Houston systems. They work very well, even when the roads are in bad condition and the track is covered with mud and water. In the cars the continual buzzing sound when the motor is working is at times disagreeable, but could probably be provided against. The motor cars are four-wheel box cars, and haul trail cars of similar pattern. There are also some long cars on four-wheel trucks made by the J. G. Brill Co., of Philadelphia, Pa., having one pair of large wheels on the motor axle and one pair of small wheels on the other axle. One car fitted with the Robinson truck was seen, having a two-wheel or pony motor truck at each end, and a third carrying axle in the middle. The motor cars are fitted with horizontal fender screens. The cars generally run swiftly and easily, but one road has such a poor track that the cars lurch and swing to an unpleasant extent. The cars are lighted by incandescent lamps, the trail cars having an electrical coupling with the motor car for this purpose. The light is not steady, varying with the power required by the motor.

The following are some notes obtained from manufacturing works at Cleveland:

King Iron Bridge & Mfg. Co.—Among contracts for the Chicago Exposition, this company has the large steel roof of the Mines and Mining Building, the erection of which is now completed; and has sub contracts for metal work and combination trusses for the Horticultural Building and other buildings. Some 80-ft. plate girder spans have been built for the Baltimore & Ohio R. R., and a considerable amount of iron building work is in progress, including a storage and market building in Cleveland, and a large conservatory at Lincoln Park, Chicago. Wrought iron cylinders for bridge piers are also in demand. Among special tools are a Bradley cushioned hammer, with a long arm to reach over a wide plate; a multiple punch for long plates, with an automatic spacing arrangement on the bed plate; also a heavy "bull dozer," for bending and shaping by means of dies, which is a very comprehensive and useful tool. There is also a plant for the manufacture of eyebars. The works are well arranged for the progress of work; material is delivered from the cars under cover, and proceeds through the shops to the painting and finishing shop, where it is loaded onto cars on a depressed track. The erection of turntables for drawbridges is done on a floor having a concrete foundation, and there is an overhead circular traveling trolley for the handling of the material. The blue print room attached to the drawing office is quite large, and has large windows with yellow glass, so that the work can be carried on without inconvenience.

Brown Hoisting & Conveying Machine Co.—This company has a large amount of work of its special type of construction on hand. It proposes to put up an extensive conveyor plant at the Chicago Exposition, and to have it in operation.

Buckeye Electric Co.—This company, which manufactures incandescent lamps, has erected a new brick factory and is putting in an enlarged plant, to be in operation by the new year. The new engine is a Corliss engine of 150 H.P., built by the Cooper Co., of Mt. Vernon, O., and steam will be supplied by a tubular boiler. Provision has been made for a battery of 3 boilers. The capacity of the present plant is 600 lamps per day; that of the new plant will be 1,500, while the factory is large enough for a plant of 5,000 lamps daily capacity. The manufacture of these lamps involves a number of processes and delicate operations, which it is very interesting to follow through. The special feature of this company's lamps is the use of a very elastic and durable filament, and great care is taken to turn out lamps of high and uniform quality. The average life is about 1,500 hours, while a test lamp has already run 4,000 hours. Competitive tests with lamps of other makes have resulted very satisfactorily for the Buckeye lamp. For lamps of over 90 volts a coiled filament is used, the end being coiled in a loop. This is to prevent sagging, and is especially adapted for lamps placed in an inclined position. For use in railway and street cars a lamp is made in which the end of the filament is supported by a platinum wire at the end of the bulb to prevent vibration. It is stated that the most severe service for lamps is in electric cars, and the next most severe in theaters, owing to the frequent change in intensity of the currents. The company reports orders on hand beyond its present capacity. President, F. H. PRENTISS; General Manager, C. H. ROCKWELL; Electrician and Superintendent, Mr. SPILLER; Assistant, Mr. MASSEY.

Western Mineral Wool Co.—This company has a plant at Cleveland with 2 cupolas and a capacity of 12 to 14 tons of wool per day of 10 hours. A new plant, with 1 cupola, is now being put up at South Chicago, Ill., in consequence of the growth of the western trade. The slag from blast furnaces is melted in the cupola at about 2,800° F., and in flowing out is struck by a jet of live steam under 80 lbs. pressure. This blows it into the collecting chamber, and the effect of the steam and the passage through the air is to give the material a fibrous structure. The plant is in continuous operation from one cupola for 10 hours, and by the next morning the wool has cooled and become ready for packing in bags. Mineral wool is largely used for deadening sound in floors (between tile arches and wooden flooring) and partitions, for pipe and boiler coverings, for the insulation of heat and sound, and for fire and frost proofing. It is used in architectural construction, in refrigerating and cold storage work, and for railway cars. President, F. H. PRENTISS; General Manager, C. H. ROCKWELL.

The Moenchenstein Bridge Disaster.

The Swiss technical experts, Profs. W. RITTER and L. TETMAJER, have lately submitted an elaborate and profusely illustrated report on this disaster, which was fully illustrated and described in our issue of Aug. 1, 1891. The substance of the more important parts of this report is as follows: The plans for this ill-fated bridge were prepared under the supervision of Chief Engineer BRIDEL, and were sanctioned by the Swiss Bundesrath, May 20, 1876. The design was for an arched span of 143 ft. length, and 23 ft. height at center; width of panels 13.1 ft. The contract for erecting the bridge was awarded to Messrs. Eiffel & Lavallois, which firm prepared an entirely new design. With the exception of a few modifications suggested by M. BRIDEL, it is the one after which the bridge was built.

Before going any further, we may first consider some of the details of construction. The thickness of the web of the lower chords was only 1 cm. (0.4 in.) which was decidedly not sufficient. The many rivet holes around the joints of the ties and struts (1 in. diam.) also lessened the strength of the webs considerably. Another fault was the eccentric fastening of the ties and struts to the upper and lower chords.

The thickness of the webs of the floor beams was also unsatisfactory. The stringers, 13.8 ft. long, ought to have had stronger webs, and near the middle vertical and lateral stiffeners. The latticed top laterals had very flimsy fastenings to the chord. The construction of the bridge had the general character of recent iron bridges of French design; none of the faces of the chords were planed; not even the material of the top chord had close fitting joints.

During the freshets of Sept. 2 and 3, 1881, the bridge across the Birs was damaged considerably. The bed of the river close to the left hand abutment was deepened by them to such an extent that about half the foundation, which was not protected by riprapping, was washed out, parted from the other (down stream) half and tumbled into the river. The right hand truss lost its bearing, the bridge became warped and the suspended end settled, by some accounts 2¼ ft., by others 16 ins. After the bridge had been raised to the former position, an examination showed that several transverse struts had received some small cracks at the joints which extended to the rivet holes. The triangular brackets at the joints were also bent. The riveting was disconnected or broken on some parts. Immediately after the bridge was raised, the damages were repaired. On top of the cracks on above named struts splice plates were riveted; the bent brackets were replaced by new ones, the rivet connections were made intact and finally the bridge received a new coat of paint. After a temporary wooden abutment had been erected the reconstructed bridge was reopened for traffic. Since the spring of 1882 the bridge has rested on the rebuilt masonry abutment. In December, 1885, some fissures appearing in the masonry caused one end of the bridge to be placed upon a nest of rollers. (The details of the changes made last year were fully described in our issue of Aug. 1.)

Notwithstanding some parts of the Moenchenstein bridge were declared to be too weak and in need of strengthening, the traffic passed over it without limitation. How often the engines of Type A with 15 tonnes wheel load, for fast trains, passed this

bridge could not be found out. According to statement of the Direction of the Jura-Simplon Ry., engines of Type A^3 T have been in use since June 2, 1890; freight engines of type C^3 T with 14.7 tonnes wheel load, since Feb. 20, 1890. These two latter types passed the bridge up to Nov. 10, 1890, 82 times in double traction. From Nov. 11, 1890, to June 14, 1891, 66 double trains with A^3 T locomotives and 27 double trains with C^3 T engines passed the structure.

Persons who witnessed the catastrophe say that the bridge collapsed at the center of the span behind the second locomotive. An examination of the ties of the structure shows that most of them were damaged on the right hand (up stream) side, but that there is no continuity of traces of any derailment. The grooves caused by the wheel flanges are found on either side of the ties, which goes to show that they must have been creased while the bridge fell. This fact, together with the statements of the men on the locomotives, makes it safe to conclude that any derailment was out of the question.

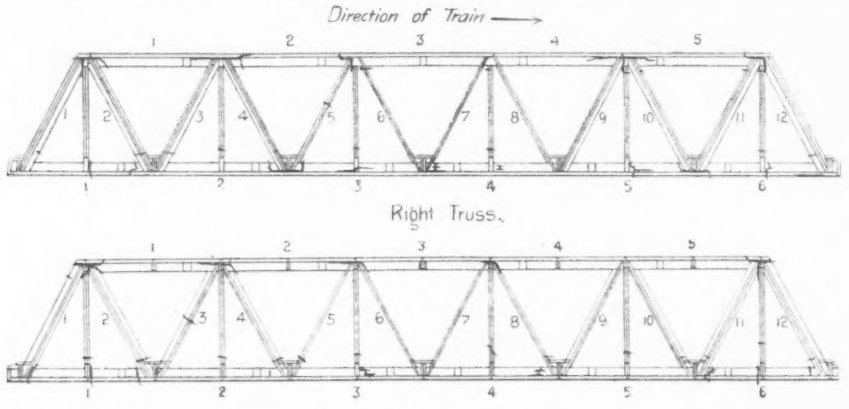


Fig. 1. Diagram of Fractures Sustained in Moenchenstein Bridge.

The iron structure, after the catastrophe, was so completely wrecked that it would be impossible to describe it adequately. The number of cracks, fractures and bends in the collapsed structure was very great, and it is hard to assert whether they were causes or effects of the disaster. The whole structure, after the accident, showed a decided turn to the left, which shows that the right hand truss collapsed first. Perhaps the first locomotive, falling to the right (up stream), may have added to this. Most of the fractures of the trusses occurred in the vicinity of the abutments. Toward the center of the trusses the chords were mostly still connected with the ties and struts, and only bent or slightly cracked. The upper chord of the left truss, for a length of about 65 ft., and the right hand one for a length of about 40 ft., remained nearly straight. Both bottom chords were entirely broken through near the abutments. The left one for a length of 10 ft., the right one for some 80 ft., were still unbroken, but much bent at points. Joint 5 (Fig. 1) of the right hand truss was damaged the worst. There the web was entirely torn away for a length of 4 ft. The connected parts of the lower chords were slightly bent vertically, which, however, might have been caused either by their settling upon the uneven bottom of the river or by the process of raising.

Most of the floor system lay at the bottom of the river; only the ends were resting upon the shores. Almost all floor beams and stringers were damaged by the falling cars and locomotives, some of them literally smashed. The impression gained in viewing the débris was that some part of the right hand truss at about the center of the structure settled and caused the structure to collapse. The maintenance of the iron structure does not seem to have been at fault. The materials of the structure were wrought iron of varying quality; the rivet iron seemed to have been good, and the material for the ties and struts, floor beams and stringers. The angles of the chords are of dubious quality; their mean ultimate strength is just sufficient for the low grade prescribed by the French rules, but their maximum ductility only reaches the minimum of those rules.

Of the same material is the iron used for the struts and ties and the webs of the chords. The webs of the floor beams and stringers were very inferior. Altogether the iron used for this bridge, with a few exceptions, was entirely unfit for bridge construction. Longitudinal seams caused by welding, such as were apparent on the webs of chords, explain for the most part the position and shape of the cracks and fractures sustained during the collapse of the bridge. By riveting stiffening angles to the top of floor beams and connecting the ends with the ties and struts, the free length of the two latter had been lessened about 3.28 ft. and their compressive strength increased, but the vibratory strains were great, and add to this the sudden change from compression into tension, or vice versa, to which strut 6 was subjected, and it seems apparent that there was immediate danger of a fracture if the load was traveling fast. During the time of one second the compressive strain of this strut rises from 0 to 15 tonnes, goes back to zero the next second and rises to 14.5 tonnes tension the third second. When two locomotives were passing at high speed it is easy to understand that struts 6 and 8 were strained in a dangerous way, and were loaded with more than they could possibly carry safely. The designer of the structure did not consider that strut No. 6, on which there is a tensile strain while the bridge is loaded, has sometimes to resist considerable compression. The ties, on account of their small area, expand proportionately very much, so that the lower chord, while a train was passing, went through a wavelike motion, which was mitigated only by the stiffness of the stringers. This may explain the numerous bulges and bends to the side which the webs of the bottom chords sustained in the vicinity of the joints. [These last are amply explained as effects of the disaster.—ED.] The proper limit of elasticity must have been exceeded repeatedly, which of course would cause a permanent set in the material. The obliqueness of the bridge was also the source of a number of subordinate strains: the trusses would resist unequally under a load; the uneven settling of two opposite joints would cause a bending of the structure sideways, and a passing train generate stronger vibrations than in a right angled bridge. The struts, calculated to resist compression, especially the sixth and eighth, were designed entirely too weak, and the eccentric connection of ties and struts caused remarkably high strains. Each of these two facts seems sufficient to cause the structure to collapse.

The experts conclude that the accident happened in the following manner: As the train was nearing the middle of the bridge the sixth strut of the right hand truss bent sideways so as to cause a flaw on account of the vibrations due to the fast running locomotives, and thus lost most of its strength. Supposing the latter to be wholly lost, there originated in the third joint of the top chord a transverse force which brought to bear upon the lower edge of the chord a tensile strain sufficient to cause a fracture through the whole chord. This caused a local settling of the right hand truss with settling of the whole bridge and overweighting of several other struts. The already endangered struts close to the abutments were weakened by this to such an extent that they gave way and caused the collapse of the bridge by their fracture. Certainly the left hand truss became overweighted by the giving way of the right one, and sank almost at the same time. The sixth strut of the Moenchenstein bridge had long been subjected to a strain exceeding its capacity, and the accidental acting together of several unfavorable conditions simultaneously made it bend and lose its resisting power.

SUMMARY.

The bridge was weak in several parts and faultily constructed.

The iron used for its construction was for the most part of poor quality and did not attain the necessary grade for the service.

The structure was permanently weakened at the time of the freshets in 1881.

The changes toward strengthening the bridge in 1890 improved the condition of only a few parts; the rest remained essentially the same as before.

There was no derailment.

The main cause of the accident lay in the weak struts in the middle of the bridge; the eccentric fastening of struts and ties and the inferior quality of the material accelerated the collapse of the structure considerably.

Alternation of Strains in Member 6 (Right Turns) in 6 Seconds: Moenchenstein Bridge.

Disputed Points in Bridge Design.

(*Continued from page 564.*)

B.—WIND PRESSURE.

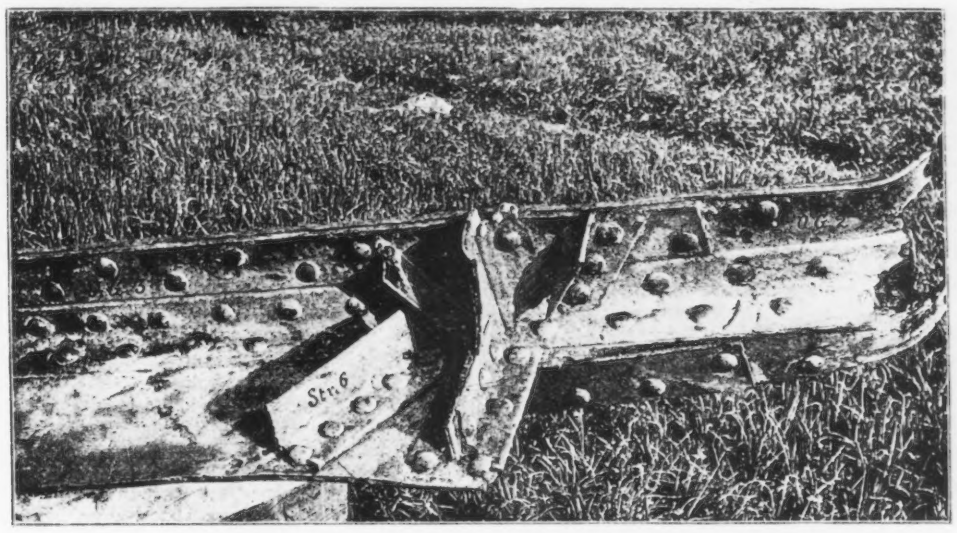
We will divide the subject into two parts, viz., "Amounts" and "Effects." In respect to the former the practice has of late years changed somewhat, the tendency being to reduce the intensities specified and to provide more thoroughly for the effects. For instance, many of the older specifications called for a pressure of 50 lbs. per sq. ft. of surface on both sides of the span, when the bridge is empty, while in fact nearly every structure designed by said specifications would double up like a jack-knife under such a pressure. In most of the modern specifications, instead of stating the amount of wind pressure per square foot of surface, the amount per lineal foot for each chord is given, that for the loaded chord being 450 lbs., and that for the unloaded chord 150 lbs. For short spans this method is all right, in that it prevents the use of too light lateral rods and struts, but for long spans the amounts are too small. The writer has verified this statement a number of times lately in the designing of unusually long spans, more especially where the structures have to carry both railway and highway traffic. In one case, for a span of 500 ft. the total pressure figured for an intensity of 30 lbs., ran as high as 900 lbs. per lin. ft., and in another case for a 560 ft. span, figured for an intensity of only 25 lbs., it ran as high as 1,100 lbs. per lin. ft. It is true that these spans were intended to carry both railway and highway loads; but even had they been intended for railway traffic only, the total pressure per lineal foot would have overrun considerably the 600 lbs. ordinarily specified. In the writer's opinion the best specification for wind pressure would embody both methods, using the standard 600 lbs. as a minimum, and calling for intensities on the empty structures varying between 40 lbs. for very short spans and viaducts and 25 lbs. for very long spans, those on the loaded structures varying from 30 to 25 lbs.

In respect to areas opposed to wind pressure, it is the writer's practice to double the area of the vertical projection of one truss, deduct therefrom the area of the leeward web protected by the train, and add to the difference the area of the floor system found by multiplying the span length by the vertical distance from the top of the guard rail to the bottom of the stringer. If the lower lateral diagonals be not protected by the windward chord or by the stringers, their area is to be included also.

Now as for the "Effects" of the specified wind loads, the most important of these are too often entirely ignored

by computers, especially in competition, for it does not suffice to calculate the stresses in the lateral diagonals and stop there. In good practice the effects of the wind loads are followed from the points of application until the masonry is reached, and both the direct and indirect effects are considered. By direct effects are meant stresses which come directly from the loads, such, for instance, as the tension on the leeward bottom chord from the loads of the lower lateral system. By indirect effects are meant those which do not come so directly (and are, therefore, too often ignored), such, for instance, as the increase in the tension of the leeward bottom chord due to the load that is transferred from the windward to the leeward side in resisting the overturning moment of the wind loads of the upper lateral system, or the somewhat complicated wind stresses in the inclined end posts of through bridges. The latter subject will be treated later, but the former might as well be taken up here.

The amounts for the transferred load stresses cannot be determined with accuracy, but as they are large, it is not proper to ignore them for such a reason; because by making certain assumptions they can be found approximately. If, for instance, there were no upper lateral diagonals, and the wind loads on the top chords were therefore carried to the lower lateral system by means of the overhead transverse bracing, there would be transferred from the windward to the leeward truss at each panel point a load equal to the product of the wind load at the top chord panel point and the truss depth, divided by the perpendicular distance between trusses. The resulting tensions on leeward bottom chord (which are the only stresses from this source that are of any importance) could be readily calculated, and



VIEW OF JOINT IN WHICH FIRST FRACTURE OCCURRED—MOENCHENSTEIN BRIDGE

would be found to increase from end to middle of span. But, again, if there were no overhead vertical bracing, the wind loads applied at the panel points of the top chord would be carried entirely by the upper lateral system to the upper ends of the inclined end posts, and thence down the same to the piers, producing a release of load on the windward pedestal and an increased load on the leeward pedestal. The latter, if the chords were parallel, would produce a tension on the leeward bottom chord that would be constant from end to end of span; or, if the top chord were broken, one that would decrease from end to middle of span.

Now, as in general, the upper lateral system has, or ought to have much more rigidity than the overhead transverse bracing, the probability is that most of the upper wind loads will travel by the former; so certain engineers, and of late among others the writer, have been in the habit of assuming for convenience, that they travel entirely in that way, and that in consequence the stresses from transferred loads in both leeward and windward bottom chords are constant from end to end of span, provided the top and bottom chords be parallel. The writer has gone a step farther by assuming that this holds good even when the top chord is broken; and, perhaps, here he is nearer the mark than in the case of parallel chords, for on one account the stresses tend to decrease from end to middle, and on another account they tend to increase in the same direction.

The released loads on the windward pedestals cause a decrease in the dead load tensions of the windward bottom chord, and this effect should be added invariably to the compressions in said chord from the wind loads of the lower lateral system when testing for reversing bottom chord stresses with empty structure. Too often this is ignored by computers, especially when competing for contracts

C.—STYLES AND PROPORTIONS OF BRIDGES.

As before stated these, by a process of elimination, are being gradually reduced to a system, although certain well known engineers persist in adhering to antiquated types. Experience has shown that for spans up to 90 or 100 ft., plate girders are the proper thing to use. They should, however, be built in one piece at the shops and never spliced in the field. This will limit the span for such structures to three car lengths, the weight during shipment being carried entirely by the outer cars, the intermediate one being an idler.

On account of the unavoidable uncertainty concerning stress distribution that exists in riveted connections, plate girders whenever they can be used are preferable to lattice girders. The latter, however, as through bridges, for single track spans between 100 ft. and 150 ft. in length, and for double track spans between 100 ft. and 125 ft. proper style of structure to adopt. However, they should invariably be built upon the single cancellation principle instead of, as ordinarily, with several systems of intersection. The latter method is not only unscientific, but also extravagant in the use of metal; and the claims of its advocates that it is superior to the Warren type are imaginary and unfounded.

It is evident from the preceding that the writer would rule out entirely the pony truss bridge. His reason for this is because of the uncertainty in computing the strength of the top chord. In the first place, its length as a strut is indeterminate; and in the second place the side bracing, when attached to shallow floor beams, as is often likely to be the case, is liable to do more harm than good by forcing the panel points of the top chord out of line. The only satisfactory method of determining how to build good pony-truss bridges would be to construct a number of them and load them to destruction, thus ascertaining their weak points, and making, if practicable, the necessary corrections. But would not this be a case where *"le jeu n'en vaut pas la chandelle?*

For spans exceeding 150 ft. for single track bridges and 125 ft. for double track bridges, the Pratt truss, with its vertical intermediate and inclined end posts, has proved to be the most satisfactory structure, although one of our prominent bridge engineers is advocating a truss with posts of varying inclination to the vertical. His principal claim for superiority for this truss is economy of material, but in the writer's opinion this is much more than offset by several inferior details, prominent among which is the suspended floor beam. It is hoped by the writer that the gentleman referred to will consider the foregoing as a sufficiently severe attack upon his pet truss to warrant his bringing up the subject for a thorough discussion by the profession.

The principal objections to suspended floor beams are their lack of rigidity to resist vibration, and their inefficiency to act as lower lateral struts.

It has been whispered that riveted connections of floor beams to posts are not as perfect as they are held to be, but the writer has yet to hear of the first case of failure of the rivets in this connection when the beams were well proportioned and of the proper depth, although he has himself seen cases where extremely shallow and weak floor beams could not be retained to the post by any practicable means.

Beyond the limit of about 250 ft. (more or less according to the lightness or heaviness of the load carried) it is well to economize metal by adopting what is termed by some engineers the "Pettit" truss and by others the "subdivided Pratt truss," inclining the top chord as may seem advisable—in fact the top chord may be inclined or broken to advantage in Pratt truss spans exceeding say 175 or 200 ft. In the Pettit truss the writer has become convinced that, in dividing the panels, it is much better to carry the intermediate panel load by a strut toward the pier than to take it by a tie toward the center of the span, even if the former method require, as it often will, more metal because the rigidity of the truss as a whole is thereby increased, and the top chord sections are much more perfectly supported at mid length.

INCLINATION OF TOP CHORD TO THE HORIZONTAL.

This feature can be and is sometimes carried to excess. Its effect is undoubtedly to economize in metal; but at the same time its excessive use will throw too much work upon the top chord and leave very little to be done by the web, which therefore becomes light and vibratory. Again, with excessive curvature of top chord, the stresses in web diagonals are liable to reverse. If such reversion or tendency toward reversion be provided for adequately by stiffening the diagonals, it is true that the objection vanishes, but at the same time so does the economy. In the extreme case of a parabolic top chord, toward which some of our latest long spans approach closely, every panel would need counterbracing, in order to transfer the advancing live load; and surely no well posted engineer will claim that the parabolic truss bridge is a good structure to adopt.

It is the writer's practice, when designing a bridge with inclined top chords, to figure the advancing live load stresses for both tension and compression upon every web member in the truss from pedestal to pedestal; then, after allowing whatever seems advisable for impact, to determine what diagonals will need stiffening and what will not. The percentage to be allowed for impact is a matter of judgment, and will depend largely upon the character and velocity of the advancing load.

MINIMUM DISTANCE BETWEEN LONG THROUGH TRUSSES.

This is still an undetermined point, some engineers making it $\frac{1}{20}$ and others $\frac{1}{14}$ of the span. The writer is now inclined to adopt a middle course by calling it $\frac{1}{19}$ of the span, although he once designed some 500 ft. spans with a perpendicular distance between trusses of 25 ft. It is hoped that those engineers who think that the smaller limit will induce too much vibration, will, in the discussion of this paper, give their reasons for so thinking. In case of deck structures either the limit for the perpendicular distance will have to be increased or the truss depth will have to be decreased in comparison with the same dimensions for through bridges, on account of the greater overturning moment of the wind pressure; and for through spans of medium length, say 250 ft., the perpendicular distance between central planes of trusses should be much more than $\frac{1}{19}$ of the span. The writer would suggest the following table for through spans of railway bridges.

Span.	Least perp. dist. between centers of trusses.	Span.	Least perp. dist. between centers of trusses.
250 ft. and under	18 ft.	450 ft. and under	25 ft.
300 " "	19 "	500 " "	27 "
350 " "	21 "	550 " "	29 "
400 " "	23 "	600 " "	31 "

The writer is an earnest advocate of the increasing of clear roadways from 14 to 16 ft. for single track through bridges, and from 27 to 29 ft. for double track through bridges. The extra 2 ft. of width thus gained, together with a properly designed floor system and efficient protection and re-railing apparatus at each end of the bridge, would do away with fully 90% of the bridge accidents caused by derailments, and thus deprive the opponents of pin-connected bridges of their sole argument worthy of consideration.

The maximum allowable truss depth, except for draw bridges, in the writer's opinion, should never exceed three times the perpendicular distance between central planes of trusses; and when the extreme depth is used at mid-span it should be reduced toward the ends considerably.

For several years past the writer has held the opinion that in important bridges the lower lateral systems should be rigid, and he has now about come to the conclusion that an adjustable member is better out of any railway bridge than in it. However, he is not yet prepared to abandon entirely the use of adjustable members until such time as the profession will begin to agree with him substantially in this opinion.

THE PROPER PANEL LENGTH FOR TRUSS BRIDGES.

The tendency of late years has been to increase this length for the purpose of saving metal not only in the eye-bars but in nearly all the other members of the structure; but, while saving metal, some designers have gone a little too far by using eye-bars too shallow for their lengths. Such proportions as 30 ft. length and 4 ins. depth are not unknown; but what the sag of these bars is the writer cannot say. Although not entirely guiltless himself in this particular, he has for several years been endeavoring to reform by adopting the following table, occasionally departing from it slightly, but in all such cases compensating or endeavoring to compensate by the use of extra section in the member:

Unsupported hor. length.	Min. depth of bar.	Unsupported hor. length.	Min. depth of bar.
15 ft.	2 ins.	24 ft.	5 ins.
16 ft.	2½ ins.	27 ft.	6 ins.
17 ft.	3 ins.	30 ft.	7 ins.
18 ft.	3½ ins.	33 ft.	8 ins.
20 ft.	4 ins.	40 ft.	10 ins.
22 ft.	4½ ins.		

The theory has been advocated by a prominent engineer that the use of shallow bars for long panels can do no harm; for by the formation of a catenary in the bar the metal is not overstrained; but such a theory does not appear to the writer to be tenable. Long panels for wide bridges are all right, but for single track spans of short and medium lengths, extraordinarily long panels cause the lateral diagonals to act with too small an inclination to the planes of the trusses, and thus lessen their power to check vibration.

SPACING OF STRINGERS.

As to this there seems to be considerable difference of opinion among engineers. Some say that they should be placed exactly under the rails in order that the load may be applied directly, while others space them as much as 9 ft. and even 10 ft. apart so as to economize on metal in floor beams. If the former method be adopted, outer stringers should be used so as to support the ends of the ties in case of derailment. This, of course, increases the weight of metal, and is, therefore, objectionable, if a more economical and equally effective system can be designed. As a matter of fact, can any one point to a case where metal stringers have been injured by the bending down of the horizontal legs of inner upper flange angles, and if there be such a case, was there not some glaring weakness in the floor system proper? Statistics on this subject would be valuable.

FLOOR SYSTEM.

For several years the writer has adopted the following floor system: metal stringers spaced 8 ft. centers; pine ties, 8 x 12 ins. on edge, and dapped 1 in. into stringers, each tie being bolted at each end through the stringer flanges and outer guard timbers with ¾ in. bolts staggered in respect to the flange angles; outer guard timbers, 6 x 10 ins., or 8 x 10 ins., dapped 2 ins., onto ties, which are spaced, as nearly as may be, 13 ins. centers, leaving openings of 5 ins., and inner guards either of 5 x 4 x ½-in. angle iron, or of 6 x 6-in. timber dapped 2 ins. onto ties and faced on the sides next to the rails with 3 x 3 x ⅜-in. angle iron, screw-bolted to the timber, the guard timbers being bolted to alternate ties with ¾-in. bolts. Certain railway engineers have objected to this system, because of the difficulty of replacing ties. They say that only every third or fourth tie should be bolted, and that the bolts should not go through the stringer flanges, but should grip the same by one-sided heads. The reply is that the system was designed not to make it easy of replacement, but to make it difficult to break up or remove in case of derailment; for a floor system should be so built as to be able to carry a train entirely derailed across the structure without injury to the latter. The writer thinks that this floor system on bridges having 16 or 29 ft. clear roadway, and provided with proper re-railing devices and collision piles in the embankment near the ends, will afford the best possible protection against failure of structure by derailment.

If any one has a better floor system than this let him describe it in his discussion, and show why it is superior, after which the writer will be only too happy to abandon his system and adopt the better one.

Opinions differ concerning the use of pine and oak for floor timber. The writer's preference for the former is due to the fact that oak is unsatisfactory because of its warping and splitting. Moreover, when it gets old, dry-rot sets in and forms a punky material that is easily ignited. Good pine is decidedly superior to oak; but one should not economize on the depth of the ties when the stringers are much spread, for the strength of timber is usually overrated.

(Concluded on page 621.)

Rebuilding the Mystic River Drawbridge.

The New York, Providence & Boston R.R. Co. is replacing the old wooden single track drawbridge over the Mystic River, 10 miles east of New London, Conn., with a double track steel structure, built by the Boston Bridge Works. The old wooden draw-span rested on an octagonal masonry pier, which was built in 1857 under the direction of A. S. MATTHEWS, of Stonington, Conn. No plans or records of the work on this pier were in existence, and it was decided to make a thorough examination before making any use of it to support the new steel structure.

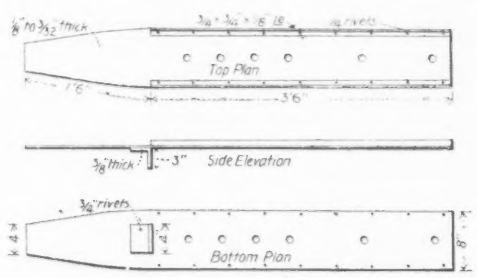
The base of the pier was surrounded by rip rap, and this was first removed by a diver, who shoveled it into a wire basket holding about 3 cu. ft., which was hoisted by hand power. In 2 months 150 cu. yds. were removed by this method. A coffer dam 42 ft. square inside was then built around the pier. The earth dam was 4 ft. thick, and the sheet piling was driven 10 ft. below the river bed into hard material. The dam was thus made so tight that a small hand pump was sufficient to take care of all leakage.

The old pier was in excellent condition. It was founded on piles cut off under water by a diver. On the piles was placed a wooden platform, 36 ins. thick, built of 12 × 12 in. and 8 × 12 in. timbers, fastened together by screw bolts. Upon this platform five courses of masonry were laid, and at low water it was lowered by screws upon the pile foundation. The rest of the masonry was added at low tide.

To protect the timber platform from injury by the toredo it was driven full of small nails. The rusting of the heads was expected to form a coating over the surface of the timber close enough to stop the progress of any worms which might work through the layer of rip-rap. Contrary to expectations the iron was not much corroded by the salt water, notwithstanding its 34 years' immersion. Neither the nails nor the bolts showed a great amount of rust. The old piles were tested with augers, and were found perfectly sound. The old masonry was therefore left intact to form the core of the new pier. The new masonry is also founded on piles, and the space around their top was filled in solidly with concrete. The contractor for this substructure work is Mr. JOSEPH ROSS, of Boston, Mass.

Iron Poling Boards Used at the Howard St. Tunnel, Baltimore Belt Railroad.

By an error in making up our forms last week, the accompanying cut was omitted from page 585. It illustrates the iron poling boards used with a system of segment timbering which was tried at the Howard



Iron Poling Boards Used with Segment System of Timbering in Howard Street Tunnel, Baltimore Belt Railroad.

St. tunnel of the Baltimore Belt R. R. The system was abandoned after drifting about 40 ft. with it, for reasons which were fully explained last week.

Report of the Railway Commissioner of Michigan.

The report of the Railway Commissioner, Mr. CHAS. R. WHITMAN, shows 6,957 miles of railway in operation in Michigan at the close of 1890, which is double the mileage in operation 13 years ago.

As an example of the fallibility of official statistics, we note the statement in this report that an error of 213 miles was made in the last report in giving the total railway mileage of the state. The total increase of mileage in 1890 is given as 218 miles, with a decrease of 21.10 miles. There are many sections of the state where the removal of the pine forest leaves a sandy desert. Two cases are reported in which branch lines, presumably in these sections, have been abandoned. The Attorney General has brought suit to compel the reopening of these lines. Just how the state can compel a railway company to do business at a loss, if it chooses to abandon its property and go out of business, is not very clear. It is true that in the cases cited the abandoned lines were branches of large systems, but these cannot be forced to do business permanently at a loss. Any enterprise which does not pay the cost of its operation, and which has no prospect of doing so in the future, is plainly not worth what it costs; and it would be against public policy to require its permanent continuance.

Some interesting figures are given in connection with the roadway department. There are 1,266 track sections in the state, having an average length of 5.49 miles, maintained by gangs averaging 4.04 men to each section. During the year 644.84 miles of track, being 9.23% of the mileage within the state, was relaid with new steel rails. Of the 225 timber culverts rebuilt, 74 were replaced with iron pipe or stone; 48 with sewer pipe, and 133 were rebuilt with timber. The following table of the railway bridges in the state is of interest:

Character and material.	Ave. length. Ft.	Number.	Length. Feet.	Length. Miles.
Wood	77.0	700	53,907	10.2
Stone or iron	114.8	188	21,591	4.1
Combination	268.4	34	9,125	1.8
Trestles	113.1	2,032	229,951	43.6
Drawbridges	134.1	30	4,024	0.8
Total	107.7	2,984	318,598	60.3

During the year 4,706 ft. of trestlework was replaced with an earth fill. This is but little over 2% of the total trestling in the state. In the above list is included the new bridges built during the year, comprising 53 wooden bridges, with a total length of 5,411 ft., and 10 iron or stone bridges, with a total length of 1,841 ft.

Some complaint has been made that the National surface cattle guard does not always turn stock. Upon investigation it was found that several of these guards had become warped, leaving sufficient room between the steel bars to permit cattle to step between them. In the Commissioner's opinion, however, if this class of guard is properly put in and kept in good repair, it will answer the purpose for which it is intended and will avoid the dangers of the old pit guard.

The number of crossings of one railway by another in the state is 182, of which 146 are at grade. Of these, 68 are protected by interlocking signals and derailing switches. The law requires trains to come to a stop before crossing another railway at grade, unless protected by interlocking apparatus; and the Commissioner "believes the law is generally obeyed."

There are 7,197 crossings of highways by railways, an increase of 365 since the last report. Of these, 210 are over and under crossings, and 446 are protected by gates and flagmen, leaving 6,541 at grade with no other protection than the signboards required by law. A number of O'Neill's automatic highway crossing alarms have been in use for several months, and thus far no unfavorable report of their working has been received.

THE TROLLEY WINS IN BROOKLYN, and street railways are authorized to operate their cars by electricity upon the following conditions: Each company to give a bond of $150,000 to indemnify the city against damage; the rate of speed not to exceed 10 miles per hour; all poles to be of iron or steel and not less that 20 ft. high; poles to be erected on curb lines, and all excavation in the streets to be supervised by the Department of Public Works.

THE ENGINEERS OF THE PENNSYLVANIA SCHUYLKILL VALLEY RY. propose to have a social reunion in October, 1892, and have issued a call to all engineers and contractors connected with that work asking for suggestions as to the proper method of bringing about and conducting this reunion. Address "The Committee," P. O. Box 509, Reading, Pa.

PERSONALS.

Mr. C. L. CARSON, a prominent architect of Baltimore, M. D., died Dec. 18 at the age of 44.

Mr. G. A. COE has been appointed Assistant Superintendent of the Western Division of the New York, Lake Erie & Western R. R.

Col. WM. E. MERRILL, U. S. Engineer Corps, M. Am. Soc. C. E., whose death we announced last week, was born in 1837, and not in 1825, as stated.

Mr. DARIUS THOMAS, Assistant Superintendent of the New York and New England R. R. from 1866 to 1871, died at Waltham, Mass., Dec. 12, at the age of 61.

Mr. R. B. WILLIAMS, Superintendent of the main line division of the New York & New England R. R., has resigned, and Mr. F. E. DEWEY has been appointed to succeed him.

Messrs. J. T. FANNING, D. W. MEADE and City Engineer DUNLOP have been appointed a commission to investigate and report on an improved water supply for Rockford, Ill. Their report is expected soon.

Mr. OTTO H. MATZ, a Chicago architect who won one of the chief premiums in competing on the Court House plans some years ago, has been appointed county architect of Cook Co., Ill., an appointment worth about $25,000 the coming year.

Mr. A. G. WELLS has been appointed Superintendent of the St. Louis Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., Mr. C. J. STEDWELL, Superintendent of the Indianapolis Division, and Mr. T. J. HIGGINS Superintendent of the Cleveland Division.

Mr. E. R. KNOWLTON, Division Superintendent of the Wisconsin Central Ry., has been appointed Superin-

tendent of the Chicago & Northern Pacific R. R., vice Mr. J. T. McBRIDE, resigned to accept the position of Superintendent of the Cairo Division of the Illinois Central R. R.

Mr. WM. H. BURRALL died at Springfield, Mass., last week, at the age of 59. He was one of the engineers engaged on the original construction of the Illinois Central R. R., and in 1864 was in private practice at Springfield. Later he was a member of the firm of Hawkins & Burrall, bridge builders. He hae been consulting engineer for bridge work for the Connecticut River R. R., Boston & Albany R. R. and New London Northern R. R.

NEW PUBLICATIONS.

—*A First Book of Electricity and Magnetism.*—By W. PERREN MAYCOCK, M. Inst. C. E., &c. 12 mo., pp. 133; 84 illustrations. New York: Macmillan & Co. 60 cts.

The author is a teacher of these subjects, a lecturer on electricity and electrical engineering, and has already published "Practical Electrical Notes and Definitions." The subject matter is elementary in its form and is intended both for students and the general reader, as an easy introduction to more advanced text-books. The three divisions of Magnetism, Electrokinetics and Electrostatics are separately treated and illustrated by cuts and diagrams. The simplest possible language is used and even chemical action is so plainly described that any one can understand. It is a useful work for the purpose intended.

—*Systematic Mineralogy*, based on a Natural Classification. By THOMAS STERRY HUNT, M. A., LL. D. 8 vo., pp. 391. New York: The Scientific Publishing Co. $5.

This work of Mr. HUNT is intended to reconcile the so-called natural history method of WERNER, MOHS and JAMESON with the rival and hitherto opposing chemical classification of minerals as set forth by BERSELIUS and other writers even earlier than his time. Mr. HUNT, in 1853 discussed the possibilities of enlarging and simplifying the plan of chemical science in the interest of a more correct mineralogical system, and outlined in succeeding papers his views on this subject. His aim in the present work is to observe a strict conformity to chemical principles and at the same time to retain all that is valuable in the natural history method. He shows that chemical and physical characters are really dependent on each other and simply present two aspects of the same problem when rightly understood. Mr. HUNT also deals with scientific nomenclature in mineralogy, and while giving the terms used by MOHS, DANA and BREITHAUPT he attempts to eliminate the barbarisms that are too commonly in use. His list, while generally following BREITHAUPT, is in great part novel.

—*The Separate System of Sewerage.*—Its Theory and Construction. By CADY STALEY, President of the Case School of Applied Science, and GEO. S. PIERSON, M. Am. Soc. C. E. Second Edition, revised and enlarged. New York: D. Van Nostrand Co. 8vo., pp. 281, with illustrations and plans of work. $3.

We have already noticed this work at considerable length. It clearly explains what the separate system is, what it is designed to do, and gives practical direction for designing and building drainage systems of this type. The present edition has been entirely rewritten and much new matter has been added. Kutter's formula is further discussed, and tables of the value of *n* have been added. A chapter has also been added on sewage disposal, briefly outlining the methods in use.

—*Some Experiments to Determine Strength of American Vitrified Sewer Pipe.*—By MALVERD A. HOWE, C. E., Professor Civil Engineering, Rose Polytechnic Institute. Reprinted from *Journal of the Association of Engineering Societies.* Pamphlet, 21 pp., illustrated.

The pipes tested were made by 15 of the most prominent American makers, and were bought in the open market. They were tested by the hydrostatic, drop, concentrated load and uniform load tests, and also for the character of the cement joint. The testing apparatus is illustrated and described along with a detailed result of the experiments. The conclusions arrived at were briefly as follows: That the average ultimate tensile strength of American vitrified sewer pipe is at least 600 lbs. per sq. in.; that the average pipe will safely support 2,000 lbs. at its center on supports 16 ins. apart; that it will support 2,000 lbs. per lin. ft. when bedded in sand; that cement joints made with the ordinary belt and spigot are only safe when the pipe cannot move longitudinally; that ring joints are but little stronger under the same conditions; that the improved joint with grooves is stronger than either of the above; and, finally, if the pipe is confined, any of these three joints, properly made, will probably hold as long as the pipe lasts.

—*Experiments and Researches on Trap Siphonage.*—Showing the comparative merits of the principal appliances used for trap seal protection. By JAMES M. DENTON, M.E., Professor of Experimental Mechanics in Stevens Institute of Technology. Reprinted from Transactions of the American Public Health Association. Pamphlet. 56 pp., illustrated.

The result of a year's careful and thorough experiment at the Stevens Institute. The conclusions arrived at will especially interest engineers and architects.

—*Dictionary of Altitudes in the United States.* Compiled by HENRY GANNETT, Chief Topographer. Bulletin No. 76, of the U. S. Geological Survey. 2nd Edition. Published by the Department of the Interior, Washington, D. C., 1891, 8vo., 393 pp.—$0.25, by postal note or money order.

This work amplifies the first edition of 1884. A rough average by pages shows that this dictionary contains the altitudes of about 24,000 localities in the United States. A full schedule of authorities is presented, showing the degree of accuracy to be expected, and the individual authority is given in each case. The dictionary is arranged alphabetically throughout, and its general value to engineers and others need not be further pointed out. The edition is 3,000 copies. Address "Director U. S. Geological Survey, Washington, D. C."

—*Annual Report of the Commissioner of Railroads*, State of Michigan. CHAS. R. WHITMAN, Commissioner. Lansing, 1891, cloth, 8vo. pp. 529.

Some matters of engineering interest in this report are abstracted elsewhere.

—*Altitudes Between Lake Superior and the Rocky Mountains.* Bulletin No. 72, U. S. Geological Survey, Washington, D. C. 8vo, 229 pp. 20 cents.

This useful publication, compiled by Mr. WARREN UPHAM, gives the altitudes above the sea for the great railway systems by stations and streams, noting the distance of each point in miles from some initial point. The altitudes of rivers is also given for the St. Lawrence River system from Lake Superior to Lake Ontario; the Mississippi River and lakes near its source, to its mouth, with dates of high water; the Minnesota and Missouri River systems; the Rainy and Winnipeg River systems; the Red River of the North, Nelson, Saskatchewan, &c. A separate division treats of the altitudes of watersheds, hills, mountains, lakes and streams, on routes of geological and other surveys. A copious index of hills and mountains, lakes and towns and stations properly supplements this valuable work.

TRADE PUBLICATIONS.

—*Phosphate Mining.*—Published by the Lidgerwood Mfg. Co., New York, 1891. Handsomely illustrated. This pamphlet shows the application of suspension cableways to phosphate mining, with illustrations taken from photographs and detail views of engines, cable carriage, fall-rope carrier, &c.

—*Steam Boilers.* Published by the John O'Brien Boiler Works, St. Louis, Mo. Pamphlet, illustrated.—Shows views of the shops, with the machinery used, and illustrates and describes special boilers made by this firm, such as the Springfield down draft smokeless boiler, the two-plate steel stationary tubular boiler, the compromise boiler, &c. Full specifications of dimensions are given for each special item.

SOCIETY PROCEEDINGS.

American Forestry Association.—The tenth annual meeting will be held at Washington, D. C., Dec. 29, 30. On Dec. 29 there will be reports presented, including the report of the Executive Committee on the establishment of national forest reservations. On Dec. 30 there will be a business meeting, the presentation to the President of a memorial on national forest reservations, and a public meeting at which the following papers will be presented: "Development of a Protective Forest Policy in Europe," by Gifford Pinchot, of New York; "Development of the Forestry Movement in the United States," by J. D. W. French, of Massachusetts; "Needs of Forestry Education in the United States," by President C. K. Adams, of Cornell University; "Management of the National Forest Reservations," by B. E. Fernow, of Washington, D. C.

Since the last annual meeting, the Executive Committee has, in conjunction with the Forestry Division of the Department of Agriculture, worked up the necessary data for the recommendation to the President of public forest reservations, to be set aside under the law of March 3, 1891, which authorizes the President to make withdrawals of public lands for forestry purposes. The committee reports the President's assurance that he would give the broadest construction to the law which permits these reservations, and also the prompt action of the Secretary of the Interior, through the commissioner of the land office, in detailing agents to investigate and report upon the desirableness of the proposed reservations. The temporary withdrawal, pending the decision of final reservation, of several tracts has also been ordered. It is proposed to prepare further recommendations for forest reservations, to be submitted to the President by the Association at the coming annual meeting.

In the memorial submitted to the President it was urged that but little was gained in the interest of forest preservation by these reserves unless this first desirable step was followed by measures looking toward the establishment of a rational administration of the same, such as is proposed in the bill drafted and recommended by the Forestry Association. To bring about the passage of a bill providing for proper administration of these reservations is therefore one of the objects of this Association.

New York Railroad Club.—The meeting on Dec. 17 was held at the rooms of the American Railway Association, 24 Park Place. Fifteen new members were elected. It was announced that the "register" of the club, on the advertising patronage of which the club has relied for funds, is to be discontinued. Hereafter the proceedings of the club will be printed in pamphlet form and advertisements will be inserted in them. Mr. Walter G. Berg, Principal Assistant Engineer, Lehigh Valley R. R., read a paper on "Coaling Stations for Locomotives." Mr. H. A. Ainsworth, President of the firm of Williams, White & Co., Moline, Ill., described the Burnett & Clifton coal chute, illustrated on this week's inset sheet.

The question whether a labor charge should be made for changing a brakeshoe or a brass under a foreign car was brought up by Mr. W. C. Ennis, Master Mechanic, New York, Susquehanna & Western Ry., and after some discussion a resolution was unanimously adopted expressing the opinion of the club that no such labor charge should be made, and that an amendment to this effect should be inserted in the interchange rules.

The next meeting will be held at 7:30 P. M., Jan. 21, at the rooms of the American Society of Mechanical Engineers, 12 West Thirty-first St. A collation will be served after the meeting.

Western Railway Club.—This club visited the World's Fair grounds on Dec. 15, by invitation of Chief of Bureau of Transportation, Mr. Willard A. Smith. At the next meeting, on Jan. 18, the paper of Mr. Peck, on "M. C. B. Standards and Defect Cards," will be discussed, and Mr. D. L. Barnes will read a paper on "Recent Improvements in American Railroad Rolling Stock."

The Engineers of the Pennsylvania Schuylkill Valley Railway propose to have a social reunion in the month of October, 1892, and have issued a call to all engineers and contractors connected with that work asking for suggestions as to the proper method of bringing about and conducting this reunion. Address "The Committee," P. O. box 509, Reading, Pa.

The Engineers' Club of Philadelphia.—Meeting of Dec. 19, President Wilfred Lewis in the chair. About 60 persons present. The secretary read a paper by Mr. W. W. Thayer, accompanied by a large scale plan, describing a route for the proposed boulevard from the City Hall (or "Public Buildings") to Fairmount Park. The location of the boulevard is a straight line from the northwest corner of the City Hall to the southwest corner of Fairmount reservoir, and its cross section should not be less than 150 and preferably 150 ft. wide. The length of the proposed avenue is one and one-sixteenth miles, and the estimated cost about $6,000,000, of which $5,624,000 is for property condemned. Prof. L. M. Haupt referred to the projects for such an avenue which had been discussed some 20 years ago, and urged the great desirability of such an improvement. He preferred, however, a line starting from the North Broad St. front of the City Hall rather than from its northwest corner, as being shorter and cheaper.

The secretary read, for Prof. H. W. Spangler, an account of a series of tests upon ¾-in. round rolled iron bars. Ten such bars were taken and each bar was cut into lengths of about 16 ins. each. The first set was tested as it was cut from the bar, and averaged 31,545 lbs. elastic limit and 51,097 lbs. ultimate strength. The second set was annealed, and the third was heated to a welding heat and cooled on the floor. The fourth set was upset to 1⅛ in. diameter by 2½ ins. long. The next set had ends welded on. Another set was cut in two and welded together. Part of another set was prepared in the same way and annealed, and the balance of this set was headed. The last set was also headed in the machine on which the upsetting had been done.

The tests show that heating to welding heat and allowing to cool reduced the tenacity 4%, and increased the elongation about 16%. Heating to a cherry red and annealing increased the elongation without reducing the average tensile strength. Upset ends are probably as strong as the original bar. The welded pieces had the same elastic limit as the original bar, but were otherwise greatly inferior, the average tensile strength being about 85%. Annealing had no effect. Headed bars, if without flaws, are as strong as the original bars, but 2% of the heads were defective.

Mr. Jacques W. Redway presented an elaborate paper upon the Practical Projection and Construction of Maps, and gave a brief oral description of its salient features. He described briefly the orthographic, stereographic and equidistant projections of the hemisphere, expressing his personal preference for the stereographic. For the projection of small areas the development of the sphere on a cone was the most practicable and feasible way of constructing a map. The development of Bonne's and Flamsteed's projections from the simple cone, and the more complex polyconic projection employed in the United States and British Coast Surveys were considered. The author emphasized the importance, in depicting the details of maps, of giving to the map such character that the physical geography of the area could be read from its lines. Owing to the lateness of the hour, a description by Mr. Emile Low of a large land slide in Virginia, and a further discussion by Mr. F. H. Lewis of his specifications for bridge superstructure, were deferred, and the meeting adjourned to lunch.

JOHN C. TRAUTWINE, Jr., Secretary.

ENGINEERING NEWS

AND

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Iowa Civil Engineers and Surveyors Society.—Annual meeting at Burlington, Dec. 29. Secy., Seth Dean, Glenwood.

American Forestry Association.—Next meeting at Washington, D. C., Dec. 29, 30. Secy., Dr. Fisher, Philadelphia, Pa.

Technical Society of the Pacific Coast.—Jan. 1. Secy., O. von Geldern, 819 Market St., San Francisco.

Swedish Engineers' Club.—Jan. 2. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

Northwest Railroad Club.—Jan. 2. Rooms, Union Station, St. Paul.

Engineers' Club of Philadelphia.—Jan. 2. House, 1122 Girard St. Secy., H. Murphy.

Civil Engineers' Society of St. Paul.—Jan. 4. Secy., C. L. Annan.

Engineers' Club of Kansas City.—Jan. 4. Rooms, Baird Building. Secy., H. Goldmark.

Western Society of Engineers.—Jan. 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—Jan. 6. Secy., Arthur Thatcher, Odd Fellows' Building.

American Society of Civil Engineers.—Jan. 6. Secy., Francis Collingwood, 127 East 23d St., New York.

Engineers' Club of Minneapolis.—Jan. 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Jan. 8. Secy., E. K. Smoot, 803 Commerce St.

Civil Engineers' Club of Cleveland.—Jan. 8. Secy., A. H. Porter, 50 Euclid Ave.

Atlanta Society of Civil Engineers.—Jan. 12. Secy., Parker N. Black, Capitol Block.

Denver Society of Civil Engineers.—Jan. 12. Secy., Geo. H. Angell.

Northwestern Society of Engineers.—Jan. 12. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.

Civil Engineers' Association of Kansas.—Jan. 13. Secy., J. C. Herring, Wichita, Kan.

New England Railroad Club.—Next meeting, Jan. 13. At United States Hotel, Boston. Secy., F. M. Curtis.

Engineering Association of the Southwest.—Jan. 14. Secy., O. H. Landreth, Nashville, Tenn.

Northwestern Track and Bridge Association.—Jan. 15. Rooms, Union Station, St. Paul.

Montana Society of Civil Engineers.—Jan. 16. Helena.

Western Railway Club.—Jan. 18. Rooms, Rookery Building, Chicago. Secy., W. H. Marshall.

Engineers' Society of Western Pennsylvania.—Jan. 19. Secy., J. H. Harlow, Pittsburg, Pa.

Boston Society of Civil Engineers.—Jan. 18. Secy., S. E. Tinkham, City Hall.

Canadian Society of Civil Engineers.—Jan. 21. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.

Engineers' Club of Cincinnati.—Jan. 21 Secy., J. F. Wilson.

Scandinavian Engineering Society of Chicago.—Jan. 21. Secy., T. G. Pihlfeldt, 113 Adams St.

Southern and Southwestern Railway Club.—At Atlanta, Ga., Jan. 21. Secy., F. A. Charpiot, Macon, Ga.

New York Railroad Club.—Next meeting at the rooms of the Am. Soc. Mech. Engrs., 12 W. 31st St., Jan. 21.

IMPORTANT TO SUBSCRIBERS.

Hereafter we will not accept a subscription to this journal from subscription agents or from anybody else at less than our published rates. No club rate or commission will be allowed. Newsdealers and agents must send their orders to their News Company. This policy is one of necessity. We spare neither money nor labor in the effort to produce the very best of engineering newspapers and in justice to ourselves and to all of our subscribers we must have our full rate every time.

We shall be obliged if subscribers will deal with us direct, and it will be a favor also if they will use a printed letter-head or inclose a professional card for classification purposes: it will be of advantage to them also.

ENGINEERING NEWS PUBLISHING CO.,
Tribune Building,
July 4, 1891. *New York.*

A VERY sensible resolution was adopted at the last meeting of the New York Railroad Club, to the effect that when brake-shoes or brasses are renewed on cars belonging to another railway no charge for labor shall be made to the owner of the car. Every one can see the common sense of this rule. The more the interchange of freight cars can be simplified to do away with the red tape involved in their repair and inspection, the better it will be for all concerned. It is the introduction of such reforms as this that proves the value of the railway clubs to the railways as well as to their members.

THE argument against the use of cast iron columns in high buildings which appears in another column will, we hope, be fully appreciated by engineers and architects. Prohibitory laws against the further use of cast iron for such columns is the need of the day in all our large cities. The commercial interests in favor of its continued use are great: and they have so far prevailed, having had the two strong arguments of cheapness and convenience in their favor, though there is little left of either of those arguments to-day. But there are so many and such serious dangers and disadvantages in the use of cast iron, and they are so greatly aggravated when buildings come to be very high, that there would no longer be any real hardship to any builder in compelling him to pay the small additional price required for the better article. This is especially true in the city of Chicago, where the combination of extra high buildings with extra dubious foundations makes the loose-jointed cast iron construction particularly objectionable. We happen to know of one recent instance where one of these buildings when partly erected was found to be 6 to 9 ins. out of plumb. It was then determined to pull the building over plumb by improvised tackles, struts and screws, and then drill holes in the cast iron columns and introduce diagonal rods, in the vain hope of keeping it so. We say "vain" hope, because it is plainly all but impossible to effectively "doctor" a 16 or 18-story building in this fashion. Yet more elaborate puffs of this building have appeared in the Chicago papers than of almost any other in the city, for evident reasons.

As illustrating the essential truth of the conclusions expressed in our issue of Nov. 14 in regard to the indications of the Canadian census, and especially as to the two main provinces, Ontario and Quebec, where the increase of population has been only 9.6 per cent. (against 11.66 per cent. for the whole of Canada) a correspondent of the New York *Tribune* calls attention to the following facts in regard to the five counties of Ontario known as the Niagara Peninsula:

The soil is very fertile. All the cereals and fruits, including peaches, are successfully grown there. The Welland Canal crosses the district from north to south. In connection with the locks upon the canal there is an immense supply of water power for manufacturing purposes. Since 1881 $5,500,000 has been expended on the canal over and above the cost of repairs and maintenance. Three trunk lines of railway traverse the section from east to west, and two lines cross it from north to south. There are several manufacturing towns in the district besides St. Catherine's. A number of natural gas wells are in successful operation and some of the towns are lighted from them. The population of these counties in 1881 was 83,052, in 1891 was 78,570, a loss of 4,422 in ten years over and above the gain from natural increase and immigration. The gain from natural increase was not less than 15%, or 12,447. The district has therefore lost in 10 years 16,869 persons, or 20% of its present population, and in addition a number equal to the gain from immigration.

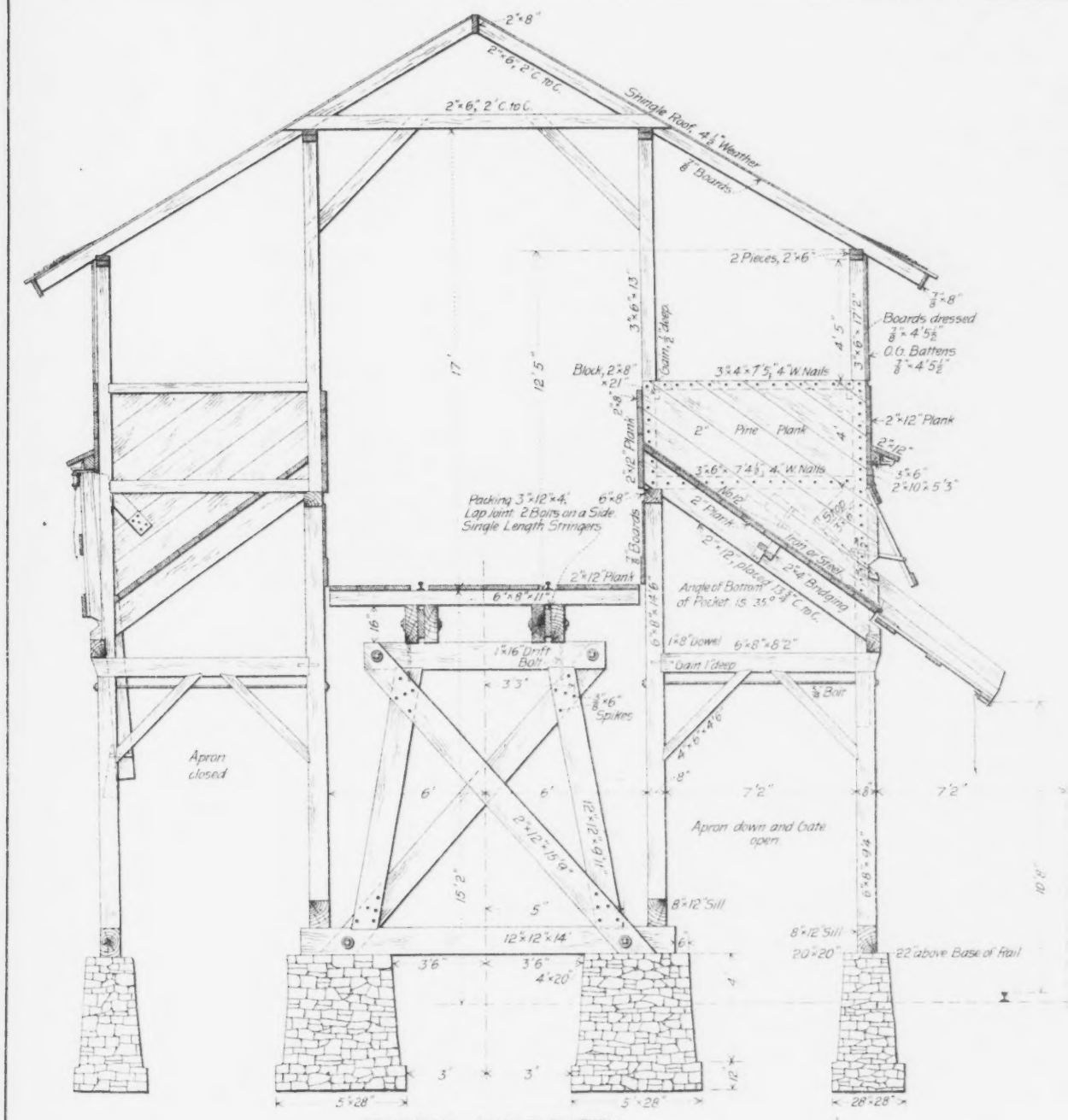
In the riding of West Durham, 30 miles east of Toronto, there has lately been a revision of the voters' list. Only taxpayers can vote there. There have been 1,768 removals of voters from the riding to the States since the last revision. The total number on the list would not exceed 5,500, so that more than 25% of the voters have gone to "join the 2,000,000 Canadians now in the United States."

It is a fact beyond dispute that to far as natural advantages go this district is the very cream of Canada. The effect of the great lakes which surround it is to greatly ameliorate its climate, its soil is good, its population still sparse, its transportation facilities almost unequaled. Yet this district has not only lost all its natural increase and all its increase from immigration but 5⅓ per cent. of its 1881 population.

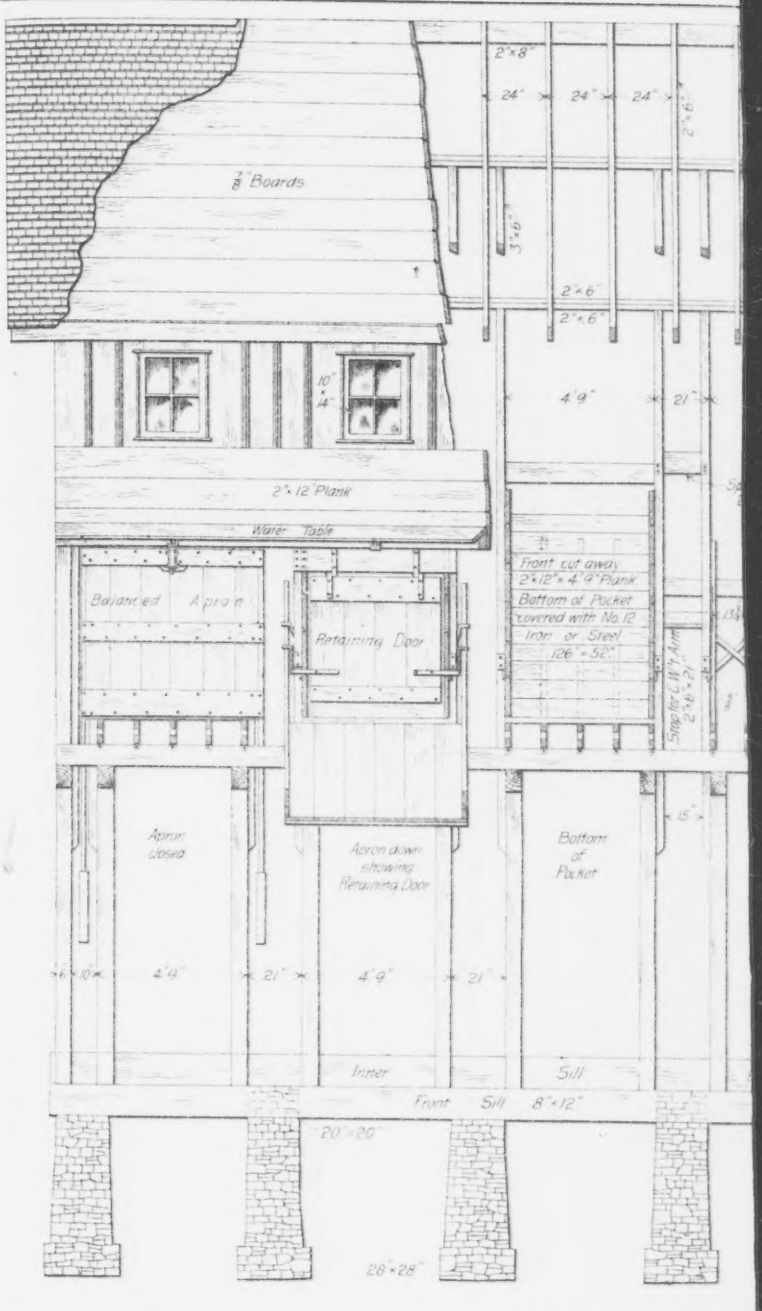
IF this district even is not able to hold its own what part of Canada can be expected to do so? It is hardly probable that the census will show so many as 2,000,000 native Canadians to be now living in the United States, but it may be very near that if we consider a fact which we wholly neglected in our discussion of Nov. 14, that somewhat over 800,000 immigrants came to Canada within the past decade, a considerable proportion of whom must have remained in Canada, since the Canadian authorities attempt to distinguish between those who intend to settle in Canada and those who are simply passing through it to the United States. Including these immigrants with the natural increase of the native population we have the following estimate of the "visible loss" of population from Canada by removal to the United States:

		Per cent. of 1881 Population.
Natural increase, 1881-91, of the 1881 population of 4,325,000, at least.....	649,000	15.0
Reported immigration, over.....	800,000	18.5
Total gross increase at least.....	1,449,000	33.5
Actual increase by census of 1891.....	504,000	11.66
Apparent loss by exodus, 1881-91.....	945,000	21.84
Living in United States in 1880.....	717,000	16.57
Apparent total living in U. S. in 1891..	1,662,000	38.41

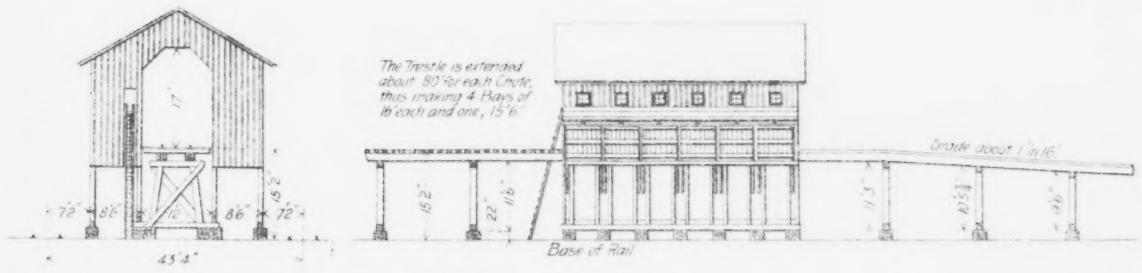
The loss by death since 1880 from the Canadian born residents who were then living in the United States should be more than made up by (1) the emigrants to the United States in the year 1880–81; (2) the similar emigrants in the year 1890–1; (3) the excess in actual rate of natural increase over the very low rate assumed: so that the actual number of Canadian born residents of the United States when reported is likely to be greater rather than less than the above estimate. When we further remember that these hosts of voluntary exiles are in the main drawn from the very cream of the population, the more ambitious and capable class, the drain upon Canada can be better appreciated. So far as the United States are concerned, the "annexation question" is settling itself in a very desirable way by individual action. It is often truthfully claimed by Canadians that their population is as large as ours was a century ago, whence the implied inference is that a century hence their population may be what ours now is. But if our increase had been only 11.66 per cent. per decade in the last century, what would be our population now? Only 11,841,009, instead of (in 1891, a year after the census) 64,000,000! If the Canadian population maintains without further decrease for a century to come the last decennial



SECTIONAL END ELEVATION.



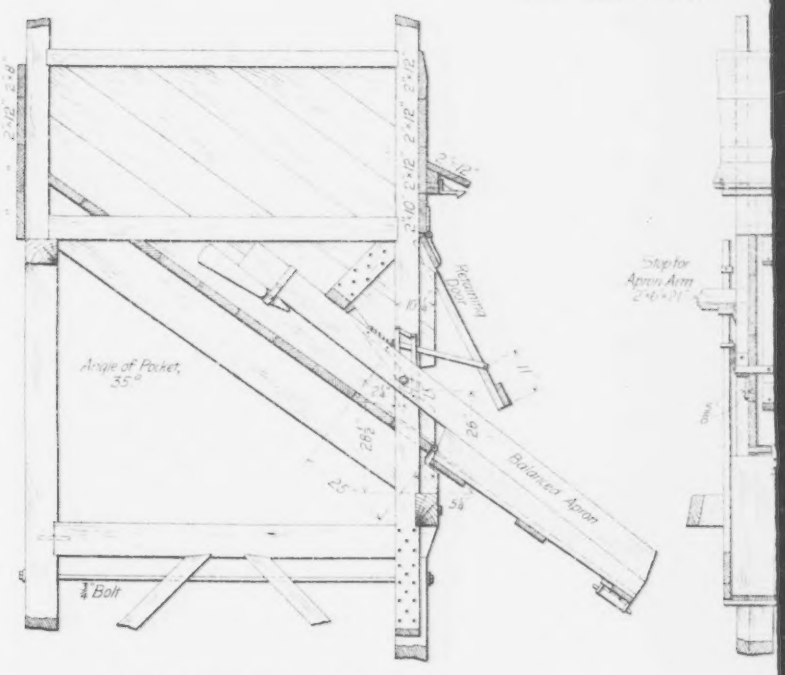
SIDE ELEVATION.



GENERAL ELEVATIONS.

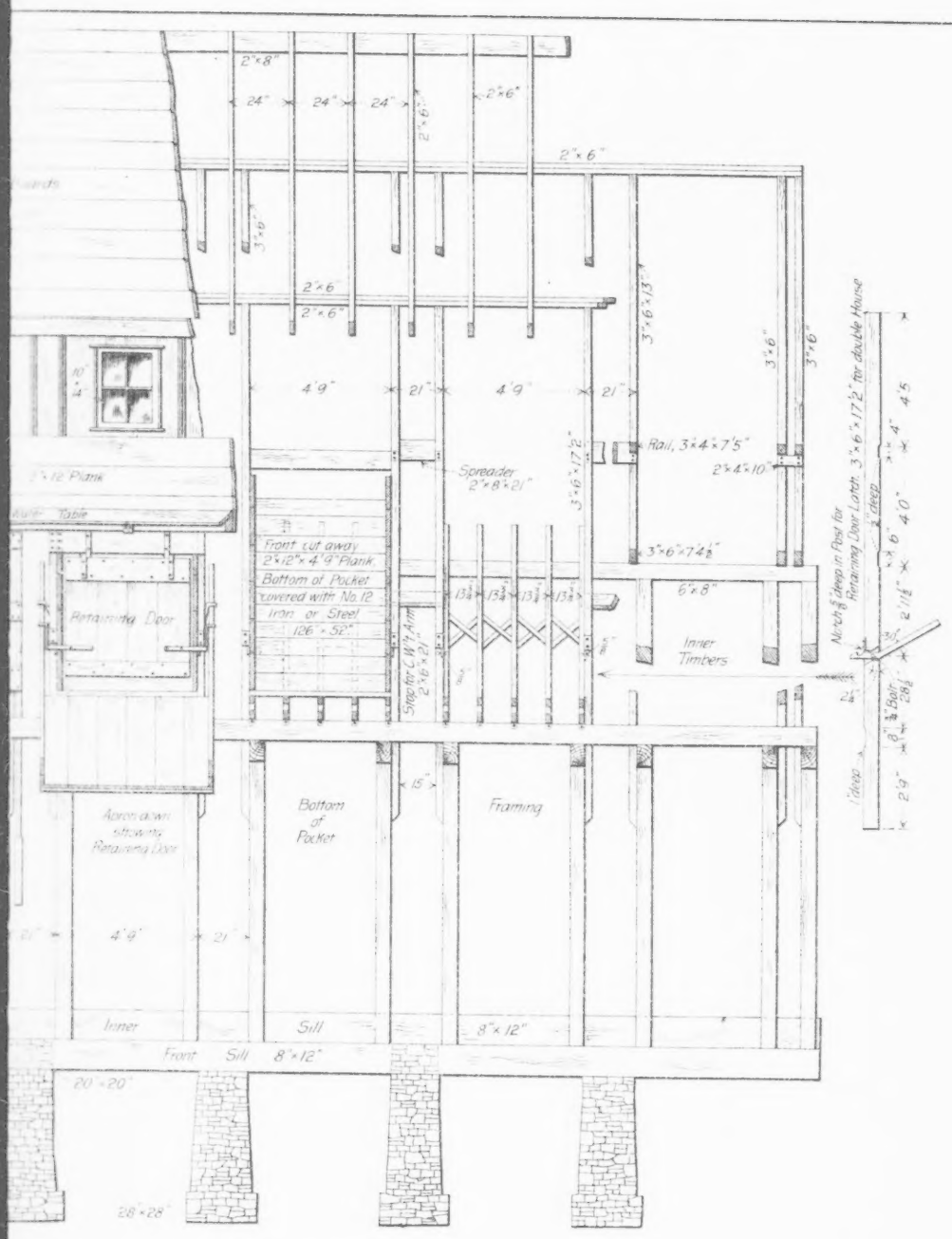
THE BURNETT & CLIFTON AUTOMATIC COAL CHUTE FOR COALING LOCOMOTIVES.

WILLIAMS, WHITE & CO., MOLINE, ILL., MANUFACTURERS.

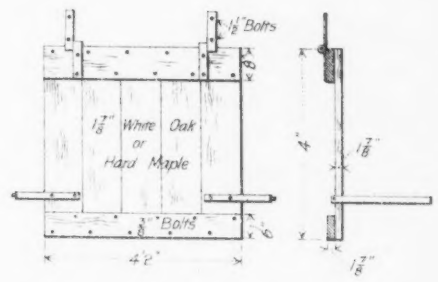


SIDE VIEW OF APRON DOWN.

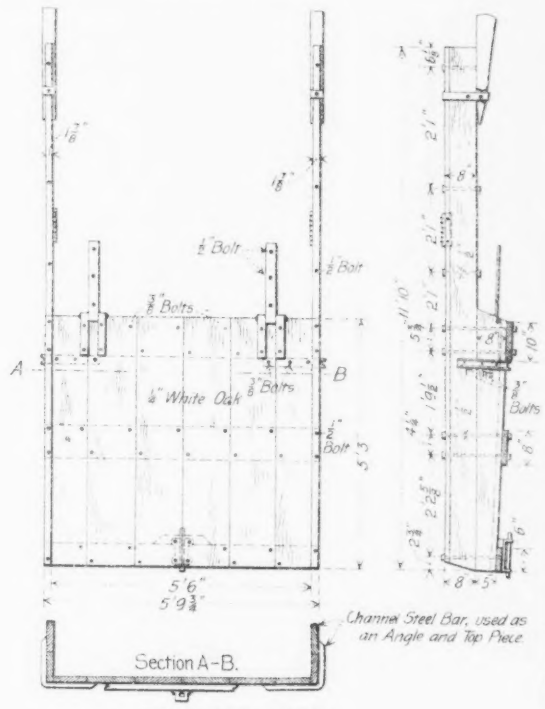
FRO



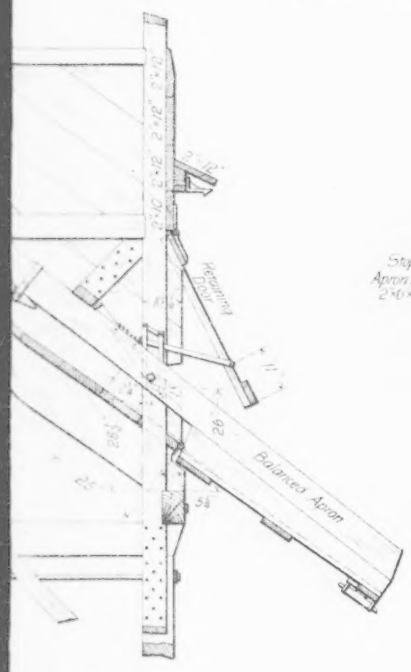
SIDE ELEVATION.



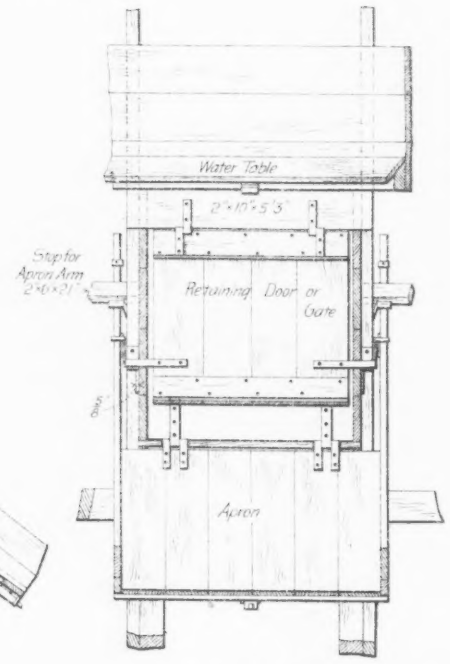
RETAINING DOOR.



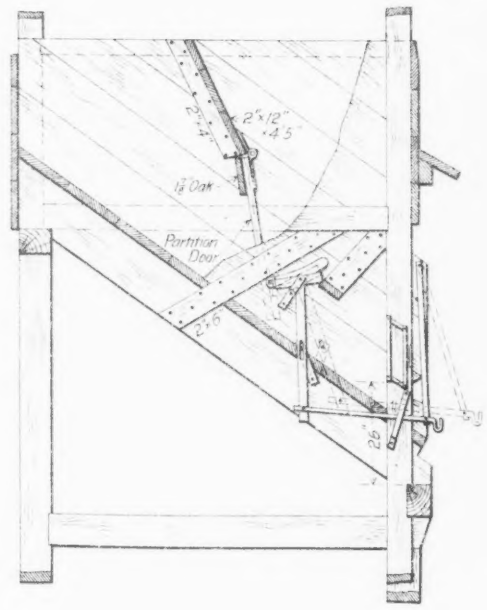
BALANCED APRON.



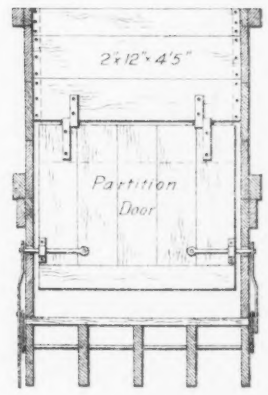
APRON DOWN.



FRONT VIEW, APRON DOWN.



SIDE VIEW OF PARTITION DOOR.



FRONT VIEW
PARTITION DOOR.

CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

130 128 126 124 122 120 118 116 114 112 110 108 106 104 102 100 98 9

B. COLUMBIA
ALBERTA
ASSINIBOIA
MANITOBA
WASHINGTON
OREGON
IDAHO
MONTANA
N. DAKOTA
S. DAKOTA
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
ARIZONA
NEW MEXICO
INDIAN TER.
TEXAS
MEXICO

Kamloops
Victoria
Vancouver
Astoria
Newport
PORTLAND
Salem
Spokane
Rathdrum
Lewiston
Walla-walla
Great Falls
HELENA
Butte
Miles Cy.
Billings
Jamestown
Valley City
Fargo
Grand Forks
Winnipeg
Watertown
Aberdeen
Mitchell
Sioux Falls
Oakwood
Douglas
Chadron
Ainsworth
Norfolk
Grand Island
Hastings
Holdrege
Lincoln
Omaha
Council Bluffs
Boise City
Pocatello
Ogden
Kramer
SALT LAKE CITY
Elko
Eureka
Carson City
Sacramento
SAN FRANCISCO
San Jose
Fresno
Keeler
Nephi
Frisco
Laramie
Greeley
DENVER
Colo. Spgs.
Pueblo
Durango
Trinidad
Dodge City
Salina
Wichita
Topeka
S. Luis Obispo
Mojave
LOS ANGELES
S. Bernardino
S. Diego
Prescott
Yuma
Gallup
SANTA FE
Las Vegas
Albuquerque
Clifton
Tucson
Deming
EL PASO
Ft. Worth
Dallas
Waco
Austin
San Antonio
Laredo
Brownsville
Chihuahua
Guaymas
Sinaloa
Jimenez
Monclova

THIS MAP shows ALL the lines of railway within its limits in their correct geographical position as they stood on Jan. 1 of the current year. For railway lines in process of CONSTRUCTION, under SURVEY, or PROJECTED, see the large scale Maps showing the divisions EAST OF CHICAGO, The SOUTH, The NORTHWEST, The SOUTHWEST, and ROCKY MOUNTAIN AND PACIFIC, issued at frequent intervals as supplements to ENGINEERING NEWS.

CORRECTIONS AND ADDITIONS to this map and to all our published data of NEW CONSTRUCTION are especially requested. Every effort is put forth to make our maps ACCURATE and RELIABLE.

118 116 114 112 110 108 106 104 102 100 96

CHAS HART & SONS LITH. 86 VESEY ST. N.Y.

ENGINEERING NEWS SERIES OF MAPS: No. 30

UNITED STATES.

THE RAILWAY CONSTRUCTION OF FIVE CONSECUTIVE YEARS.

TRACK LAID IN 1886	8,471 MILES
	12,667 MILES
TRACK LAID IN 1888	6,679 MILES
TRACK LAID IN 1889	5,095 MILES
TRACK LAID IN 1890	5,981 MILES

The above includes only main track, laid during each calendar year, on which regular trains are, or are to be run, to do business as common carriers of both freight and passenger traffic; thus excluding sidings, double tracking, lumber or mining roads not carrying passengers, and motor roads carrying passengers but no freight.

150 MILES TO 1 INCH

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rate of 11.66 per cent. its population will then be only 13,034,000. If the United States averages only 20 per cent. (instead of 25 to 35) its population will then be 396,000,000; if it should average only 15 per cent., its population would be 259,000,000. We state these facts in no unfriendly or captious spirit. It may be that Canada's colonial swaddling clothes have no effect to retard its growth to the full stature of manhood, and that hereafter its growth is to be much more rapid than heretofore. But be this as it may, facts are facts, which must be faced.

THE freight blockade of the present month is by all accounts the greatest which has ever been experienced on the railways centering at Chicago. Various causes have combined to produce it: but the chief cause is of course the great crops in America, occurring simultaneously with a partial failure of European crops and causing an unprecedented export movement of bread stuffs. While the Great Lakes were open, the traffic was moved without much trouble, the Western lines managing to keep their cars moving between the grain growing districts and the Lake ports; but with the closing of navigation on the Lakes, the only route to the sea coast from Chicago has been via the Eastern trunk lines; and, according to all accounts, they have proved quite unable to cope with this rush of traffic. Some of the press reports state that the grain cars now standing loaded in the Chicago yards and on sidings in the vicinity of the city, if made up into a single train, would reach a distance of 125 miles. With this state of affairs it is needless to say that the movement of grain is sadly impeded. The transportation systems of the country are like a train on an up grade—when the load of traffic exceeds a certain point the movement stops.

The present blockade seems to come nearer being general all over the country than any ever recorded. At Buffalo the storage capacity and the facilities of the railways were swamped by the flood of grain rushed in by the Lake vessels before the close of navigation. At Baltimore and New Orleans the storage capacity is practically exhausted. Even at the interior markets, like Kansas City, the rush of grain threatens to exhaust all accommodation. The need by the railways of more rolling stock is practically admitted by the recent letting of contracts for nearly twenty-five thousand freight cars; but it is not to be expected that railways will furnish cars equal to the demand at the season of heaviest traffic. The present situation furnishes a strong argument in favor of procuring additional shipping facilities for the grain crop of the West by the creation of a deep water port on the Gulf. If commodious wharves and spacious elevators were now available at Galveston, it is not unreasonable to believe that there would be a large movement of the grain of Nebraska, Kansas and the Southwest in that direction. Perhaps the bill to carry out the proposed harbor improvement at Galveston will find favor with the present Congress.

UNIFORM standard time based on the meridian of Greenwich, has made another great advance in Europe, as will be seen from the announcement in our correspondence column. Belgium has established Greenwich time as standard for railway use, and is likely to do so for all uses. Germany and Austria-Hungary have done the same for the hour meridian east of Greenwich. Holland is likely to follow. France will not long delay, it is reasonable to believe, but even without her it seems likely that more than half of the European railway mileage may be operated on standard time within a year. Every American who has traveled at home and in Europe, so as to become familiar with both systems, will appreciate how great the advantage will be to the traveling public, and as no one really loses any thing, if he does not gain, it seems reasonable to expect that within a few years Greenwich time and hour intervals therefrom will become standard for the whole civilized world.

Management of Public Water-Works.

The efficiency of municipal works depends very largely upon the form of their management, whether directly by the city or town council, by a board, or by one man. Furthermore, the efficiency of the officials or official in charge depends largely upon the method of election or appointment, whether by the mayor, the council or directly by the people. The collection of the information required for our MANUAL OF AMERICAN WATER-WORKS has enabled us to give with much more accuracy than ever before the facts in regard to one highly important class of publicly managed works, that of water-works, and the importance of the subject, and the growing interest, in all such matters, will, we think, make the summary which appears below of special value. The variations in practice in different parts of the country are, of course, due to local characteristics, embodied in the general laws of the states or manifested in the unwritten laws of the various sections. These peculiarities and other facts of interest are briefly as follows:

Inquiries regarding the board or other body in whom the management of public water works is vested elicited responses from about one-fourth of the works in the United States, or 225 out of 879. Of this 225, 23 works are managed directly by the general municipal government, 12 by a board of public works and 190 by a separate body, having a variety of names, all of which may be designated for present purposes by the title of water board. The practice in the several groups of states, the total number of public water-works, the number of works reporting and the manner of selecting water boards is shown in detail as follows:

Groups.	Number of works.		Management of public water-works vested in:					
					Water board.			
	Total.	Reporting.	Elected by Council.	Board of public works.	Appointed by Mayor.	Elected by Council.	Elected by people.	Total.
N. E.	134	41	..	..	1	6	34	41
Mid.	166	47	1	1	11	18	13	42
S. Atl.	32	14	3	1	6	4	..	10
S. Cent.	10	6	..	..	2	4	..	6
N. Cent.	255	74	8	10	15	13	28	56
N. W.	177	32	6	..	15	11	..	26
S. W.	58	8	2	..	4	2	..	6
Pac.	37	3	..	..	2	..	1	3
U. S.	879	225	23	12	56	58	76	190

In general it may be said that the municipal government has direct charge of works only in the smaller places. Boards of public works seldom have control, and of the 12 instances 10 are in the North Central States. Of these 12 it may be stated that the mayor appoints 5, the council elects 4, the people 3.

In New York, Chicago, Philadelphia and Brooklyn, and it is believed in some other of the largest cities of the country, the management of the water-works instead of being vested in a board is intrusted to one man who is either directly responsible to the mayor or to a commissioner of public works, so responsible. This is the ideal method, as under it the people may look to one man, the mayor, for a good administration of all city affairs and this official will be likely to appoint better men than would be elected by the people or by the city council, and may often reappoint incumbents from previous administrations. Like all other methods this one is, of course, open to abuses which need not be discussed here.

It has been shown above that of the 190 water boards reported 56 are appointed directly by the mayor, while 58 are elected by the council, the election in many cases, doubtless, being approved by the mayor. Boards elected by the councils are directly responsible to the general city government, and are generally to be preferred to those elected by the people, on much the same grounds as those given for appointments by the mayor. Thus 30 per cent. of the boards reported are raised to office in the most desirable way, another 30 per cent. in the next desirable and the minority, or 40 per cent., in the least desirable way. This classification, of course, does not take into account local reasons favorable to one or another method, but is based upon the general principle that one official, or as few as possible, should be directly responsible to the people, and all others to the one or to the few comprising the council.

It should be borne in mind, however, that nearly half of the boards elected by the people are in New England, where the good old-fashioned town meetings still prevail, where affairs are largely managed, as one might say, by committees of the whole, and where the direct responsibility to the people of all intrusted with public business naturally follows.

The North Central States, the local government of which, in some particulars, is similar to that of New England, have 28 of the 76 boards elected by the people, the Middle States have 13, and for all the remainder of the country but one board is reported, and that is in the Pacific States. While information regarding the management of all public works might alter the above ratios it is thought that the reports received are a fair index of the general practice of the whole country.

Next in importance to forms of management and methods of appointment is tenure of office. This is shown below for 188 public works: the total number of public works, number reporting and number of managing bodies serving for various terms being given in detail. The length of the terms are from one to six years, for life, or perpetual (see note), and the number under each, by groups and for the country, is as follows:

Groups.	No. Public Works.									
	Total.	Reporting.	One.	Two.	Three.	Four.	Five.	Six.	Life.	Perpetual.
N. E.	134	38	4	..	8	..	..	1	..	25
Mid.	166	41	16	1	7	1	3	2	1	10
S. Atl.	42	10	3	4	3	..	..	..	..	..
S. Cent.	10	6	1	4	1	..	..	..	..	..
N. Cent.	255	65	23	4	13	..	2	..	..	23
N. W.	177	21	15	6	..	1	..	..	..	..
S. W.	58	4	1	2	..	1	..	..	..	..
Pac.	37	3	2	1	..	..	..	..	..	..
U. S.	879	188	65	21	32	3	5	3	1	58

* That is, where the managing body is renewed after the same general plan as the U. S. Senate, it never consisting entirely of new members.

From the above it will be seen that for the whole United States 65 out of 188 managing bodies, or over one-third, hold office for one year only, 21 for two and 32 for three years. Eleven bodies hold office from four to six years, and one holds office for life. The number of managing bodies holding office for only one year is surprisingly small, but over against these 65 may be set almost as large a number, 58, designated as perpetual, which are never wholly composed of new members, a fixed number, generally a minority, giving place unless re-elected, to new members at recurring periods. The three to six year bodies stand a fair chance of having, through re-election, at least one old member continually among them, so that the showing under tenure of office is, after all, a good one, since the three to six year bodies together number 43, and these, with the body chosen for life and the perpetual bodies, number 102, or about 55 per cent. of the total number reporting. In addition it must be borne in mind that many of the works are under the same superin

tendent year after year, and that upon him the successful operation of the works often almost wholly depends. In many instances the superintendent is the only man who really knows anything about the works, and woe unto that city who loses such a superintendent.

The Credit for New Inventions.

In discussing this question last week, at the end of a long list of other instances where the credit for new inventions has been disputed, or where it has been claimed, after some later invention has made a process a success, by some earlier suggester who had at least "conceived the idea," we referred to the recent instance brought forward by Mr. R. W. HUNT, in his late presidential address to the American Society of Mechanical Engineers where no less a personage than Sir HENRY BESSEMER had, as he claimed, done injustice to a less known inventor.

The facts of this case seem to us for many reasons worthy of record at the present time. It belongs to a class of cases which are continually coming up; which come up with every new advance in the arts and sciences, we might almost say, and must continue to do so. There has hardly ever been a great invention for which more than one person did not claim and receive some credit. The particular invention now in question, that of rolling sheet metal from liquid iron and steel, will certainly not prove an exception, for to Sir HENRY BESSEMER belongs the unquestioned credit of having first conceived the idea, and first taken out a patent for it, 35 years ago; while to Mr. EDWIN NORTON, of Chicago, belongs the equally unquestioned credit of having revived this conception after it had "slept in oblivion for 35 years," of having produced the first working machine and the first samples of usable sheets, and of having thus brought the process for the first time to the serious attention of the industrial world: because when Mr. BESSEMER (as he then was) made his first and last suggestion in regard to it, not only this suggestion, but even the now famous Bessemer process on which it then rested, was, in Sir HENRY'S own words, "not merely under a cloud, but regarded by the trade generally as an absolute failure," so that both alike were "simply pooh-poohed and laid aside, without any serious consideration."

The question now is: How long an abandonment of this kind is necessary before a man loses the right to claim as his own an invention which some one else subsequently brings forward and perfects, and how long and how complete must be the abandonment before he is entitled to speak contemptuously and anonymously of such an inventor, who yet fully recognizes his own priority of conception?

Opinions will differ on this point, but on the facts of the case there can be no question, for they are recorded by Sir HENRY BESSEMER himself in the words reprinted in another column. They are in substance as follows:

In 1846 Mr. BESSEMER (as he then was) included in a patent for rolling sheet glass from liquid glass a process for similarly producing tinfoil and sheet lead. "This particular form of apparatus has never been put to any practical test," nor was the glass process ever successful. Ten years later in 1856, he "first announced to the world the fact that malleable iron in a molten state could be produced rapidly and in large quantities," an announcement which is still unrealized, but which was in a measure substantiated by the experiments which preceded the invention of the complete Bessemer process. It was very natural under the circumstances that this supposed possibility of producing fluid wrought iron in connection with his former unsuccessful experiments with glass and lead should have at once suggested "the idea that malleable iron or steel could be thus made not only into sheets and plates but also in thin bars or rods, by passing the fluid iron in between a pair of rolls."

This idea, "so novel and so immensely important if successful," was at once brought to a test, as described more fully in the extract repeated elsewhere, as follows: 6 or 8 lbs. of pig iron were decarbonized in a crucible and carried to a pair of 12-in. chilled rolls, used for another purpose in another room. "After several unsuccessful attempts I at last succeeded in reaching the rolls with some fluid metal. They were set about $\frac{1}{30}$ in. apart, and a thin sheet was obtained some 3 ft. or 4 ft. in length," and naturally somewhat ragged on the edges. The sheet was of excellent quality; "indeed, it *left no doubt on my mind*," Sir HENRY says, "of the entire success of this system of rolling thin sheets."

This was Sir HENRY'S first, last and only experiment on this subject up to the date of his paper. Its great interest and merit are very clear. It may hereafter prove to be another of Sir HENRY'S vast claims upon the admiration and respect of mankind. But it will be observed that it was only a single experiment of the crudest kind. All that Sir HENRY did thereafter was immediately to take out a patent, which under the loose law then prevailing in England was a mere formality, not involving any investigation into the novelty or feasibility of the invention. Under the law which then and now obtains in this country he could not have claimed a patent without demonstrating that his device as described would in fact produce sheet metal, nor maintained it before the courts if by error granted.

This was in 1857, a year or so before the Bessemer process was made a practicable possibility by MUSHET'S suggestion of the use of spiegeleisen, without which perhaps the Bessemer process would never have been heard of more, at least under that name. Even after this suggestion had been made, there were several years of up-hill work before the process reached the stage of an admitted practical success and began to return to Bessemer the princely royalties which he so richly earned.

Until this time had come it was more than excusable to let the fluid sheet metal conception lie fallow. It was the only sensible course. But by 1867 at least, when 117 Bessemer converters were in use in six different European countries, this probationary period was over. From that date to 1889, a period of 22 years, BESSEMER not only had every reasonable opportunity, but had heretofore unequaled advantages, for bringing forward any process of whose success he had no doubt: an unlimited command of means, a well earned reputation which would have caused iron masters the world over to compete for the privilege of trying any invention of his of which he declared that "of its complete success he had no doubt."

Nevertheless, he did nothing for 33 years to follow up this single experiment of pouring a dipper full of molten iron through a pair of 12-in. rolls, or to construct one of the machines which had been patented. At last, however, to quote Sir HENRY'S own words:

> I received, about two years ago, a parcel from America containing a small sample of sheet metal, *which was being successfully manufactured there*. The *person* from whom I received it informed me that it was made by a slight alteration or improvement on my patent of 1857, for rolling continuous sheets and thin bars of iron or steel direct from fluid metal.
>
> *The circumstance stated has, however, afforded me an opportunity of showing you a small sample* of a continuous sheet, produced direct from fluid metal at a single operation, and *proves beyond doubt or question the important fact that fluid metal may be chilled and formed into a continuous sheet between rolls that are kept cold*, while it well illustrates the spirit of enterprise of our American cousins, who are so prompt to recognize, to adopt and to improve upon the inventions brought forward in Europe.

The "person" who was thus "successfully manufacturing" what Sir HENRY had never made nor seen before was Mr. EDWIN NORTON, the mechanical partner of the great firm of Norton Bros., of Chicago, perhaps the largest consumers of tin plate in the world. He had then been working at the idea for some years. Whether or not he had knowledge of the early Bessemer patent when he began his experiments we do not know, but at any rate he acquired knowledge of it before he reached the stage of "successful manufacture," and what was more natural or more proper than that he should send samples to BESSEMER, with some courteous references to the "slight" alterations or improvements by which he had made the process a practical possibility, with an offer to BESSEMER of a half interest in the British patent if he chose to undertake its introduction in that country? Sir HENRY might or might not wish to accept the offer, but a courteous recognition of Mr. NORTON'S success in a heretofore untried field was at least demanded.

Instead of that, Sir HENRY proceeded to prepare the paper of which we have now reprinted nearly the whole, in which he not only suppresses all mention of the name of this "successful manufacturer" of the samples which were the only proof of the feasibility of his former suggestions, but goes farther and applies to him what is in England an insulting and derogatory expression. It is difficult for an American, with his more free and easy ideas in such matters, to appreciate how offensive a designation that of "person" is in English usage. It is a term reserved for describing dubious individuals of the servant class, and when used as in the above quotation conveys in one word a meaning which we should have to amplify into "a male being who cannot by any stretch of charity be called a gentleman," to have it understood. Not content with this, Sir HENRY improves the occasion to get in a slur at his "American cousins" as a people. He finds that this incident not only illustrates their "spirit of enterprise" but also their "promptness" (!) in appropriating "inventions brought forward in Europe."

Certainly in comparison with BESSEMER'S own action Mr. NORTON was "prompt" in bringing this invention forward, if it can be called an invention, but few just men would claim that it was an invention at all, in any proper sense of that much abused word, in the state in which Mr. NORTON took hold of it after 33 years' abandonment. Between the single crude experiment then made and "successful manufacture" there is an enormous gap, which in most such cases is never bridged, and *the man who bridges that gap*, and not the man who has the first "happy thought" of the device, is the true inventor, and the only one deserving of honor as such, for reasons which we reviewed more fully in our last issue.

Whether or not this process of rolling fluid metal will ever reach such a stage of practical success as to make the honor of having invented it worth anyone's seeking, it is as yet too soon to say. Sir HENRY is a little premature in declaring that sheet metal is being "successfully manufactured" under it. Some sheet metal has been successfully manufactured under it, but that is the most which can yet be said. We understand, however, that there are good grounds to hope that the process will soon be in use on a large scale, a complete commercial success. If so Sir HENRY BESSEMER'S claims upon the respect of mankind for his ability to "conceive the idea" of important new processes will be enhanced indeed, but not so his claims for grateful remembrance as an actual creator of them. His claims both to respect and to grateful remembrance are great enough as it is to satisfy a reasonable ambition; so great that it has been with no small regret that we have felt bound to impeach certain claims in justice to a less known man and to endeavor to make clear the grounds on which all such just claims must rest.

CORRESPONDENCE.

Uniform Standard Time in Europe.

BRUSSELS, BELGIUM, Dec. 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: You may announce in ENGINEERING NEWS that Mr. VANDENPEEREBOOM, Minister of the Railway Department, has given orders that from May 1, 1892, all the railways in Belgium must adopt Greenwich instead of Brussels time in their own service as well as in their time tables issued to the public. The post and telegraph offices must use the same time from that date. There will probably be no bill introduced to legalize standard time in Belgium, but every minister will invite all the departments under him to adopt the same time, and it is quite certain that the cities will be forced by their population to regulate their clocks according to those at the railway stations. All our principal cities but one have informed Mr. VANDENPEEREBOOM that they will do so very willingly. Standard time will thus be used throughout Belgium on and after May 1, 1892.

If I am well informed the German Time Convention, which assembles next week at Duesseldorf, will decide to adopt the time of the meridian 15° E. from Greenwich (called middle Europe time) for the public time tables, and it is hoped that a bill will be introduced in the German parliament to legalize that time.

As you doubtless know, the Austrian-Hungarian railways have standardized that time since Oct. 1. The American hour system has, as you see, conquered a very important part of Europe, and at the close of 1893 more than three-quarters of the European railways will be regulated by standard time. The Dutch railways, it is announced, will substitute Greenwich time for their Amsterdam time on June 1, 1892, when their summer service commences. Yours truly,

DE BUSSCHERE,
Chief Engineer, Belgium State Railways.

The Direction of Impact with High Explosives.

NEWARK, N. J., Dec. 15, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I would like to use a few lines of your valuable space, in order if possible to draw forth the opinions of any person or persons who may have noticed the direction of impact following the combustion of various high explosives.

The cause of this letter is the testimony of Mr. GEO. H. BENJAMIN on the SAGE outrage, as reported in the *New York World* under date of Dec. 13, 1891. This testimony was as follows:

"It was not giant powder, nor black powder, nor gun cotton nor nitro-glycerine." "Each one of these explosives would have acted downward instead of upward and sideways." "Had it been dynamite a great hole would have been blown in the floor, and poor young NORTON would not have been blown out of the window."

There seems to be a general belief that the explosive force of nitro-glycerine or dynamite is always downward. My experience has been that it is exerted in exactly the opposite direction from that in which the primal force is applied; for instance, a cartridge charged with cap on top of explosive and with fuse pointing north, the greatest force of explosion will be in a direct line south. I believe that while the tendency of all glycerine explosions, in the immediate vicinity of the explosive, is to rend, tear or, in other words, totally annihilate any and all substances, yet the true explosive force which we wish to confine, direct or use will be found to follow a straight course, almost as if the same were confined within the diameter of a large tube until its force is expended. Hoping to hear from any one who has had experience in this line, I remain, Yours respectfully, D. E. O.

[We do not agree either with the theory advanced by our correspondent or with that credited to Mr. BENJAMIN by *The World*. The ordinary law of the expansion of gases applies to all explosions; and the difference in effect between the combustion of black powder and the so-called high explosives is due to the element of time in expansion rather than to differing components. When gas is generated it expands equally in all directions, and acts with equal force upon all surrounding objects. In reference to the "downward blow" exerted by high explosives, we may use the familiar illustration of "water tamping" in a rock blast. With black powder the generation of the gas is relatively slow enough to allow it to impart motion to the water, as resisting less than the rock, and the water is blown out. With the high explosives the expansive force is generated so rapidly that there is no time to move the water before the power developed and confined by the water is sufficiently great to rend the rock. The fact that a hole was not blown in the floor of Mr. SAGE'S office may be ascribed to a certain elasticity in the floor, causing it to yield slightly under the blow. This effect may be illustrated by the Tilghman sand-blast, where a single thickness of paper will resist the action of sand grains that without this elastic intervening substance would abrade corundum, one of the hardest of minerals. As to the "direction of impact," it is safer to conclude that this will be on the line of least resistance, as above defined.—ED. ENG. NEWS.]

The Day Tension Frame.

TO THE EDITOR OF ENGINEERING NEWS:

SIR:—The principle of the "Day Tension Frame," as described in your issue of Dec. 12, can hardly be said to be a new departure in suspension bridge construction, as it has been in use for years, notably in highway bridges in the Western States. These bridges have not been satisfactory, owing, however, largely to scant material and poor construction. They have their place as cheap bridges. For the same efficiency and stiffness they are found to cost as much as, or more than, truss bridges. Long cables can under no arrangement be depended on to give the stiffness of a framed truss, under concentrated loading. With lower invert cable of different length the tendency toward distortion under concentrated load would be as shown in half-span skeleton in figure herewith; slight stretch in the tension web bracing of whatever shape, and stretch and distortion in main cables, would all act cumulatively toward deflection under load, so that a stiffening truss and "a rail of great stiffness to resist deflection" would eventually have to be depended upon for distribution.

The long three-truck car shown on right hand span is a new departure, presumably meant for a single track tangent road with one car for its rolling stock.

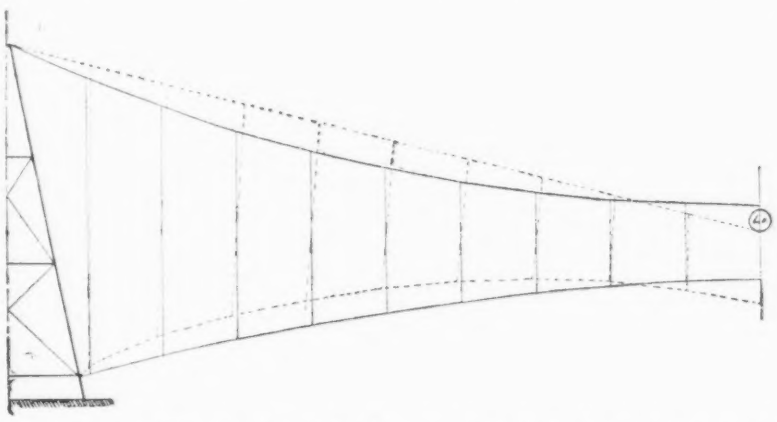


Diagram Illustrating Distortion of Day Tension Frame Under Concentrated Load.

NEW YORK, Dec. 14, 1891. W. H. B.

Notes and Queries.

C. M. S. writes: "Can you give me an explanation of the incrustation which makes its appearance on many of our handsomest brick buildings?" According to Gilmore's "Limes, Hydraulic Cements and Mortars," this efflorescence is composed chiefly of salts of potash and soda. It comes partly from the cement used in the mortar and partly from the air, being most common and in greatest quantity on the sea coast. To prevent its appearance the addition of some fatty substance to the mortar is recommended in combination with lime paste. The subject is also discussed in Baker's "Masonry Construction," and the use of impervious washes, or better still impervious mortar, is recommended to prevent the efflorescence.

What the Government Is Doing to Advance Irrigation Interests.

BY HERBERT M. WILSON, M. AM. SOC. C. E., ENGINEER U. S. GEOLOGICAL SURVEY.

(*Concluded from page 594.*)

ENGINEERING.

The work done by the engineers of the Geological Survey varies in character from rapid reconnaissance surveys, covering great areas, to the most careful and detailed instrumental work in chosen spots followed by elaborate computations and plans. In each engineering division broad reconnaissances for the purpose of discovering reservoir sites were carried on in a few cases, and in a still lesser number of cases very careful examinations were made to determine the cost and feasibility of certain water storage or canal projects which had been examined in a preliminary way. The engineers have been compelled to make statements regarding the feasibility of the larger projects in the most general and qualified manner, owing to the impossibility of arriving at definite conclusions until more is known of the actual water supply and the behavior of the streams utilized. The questions of water supply, location and proportion of dam are so interdependent that the estimates of the costs and future returns are involved in doubt, while there is uncertainty as to the volume of water flowing in the rivers. From the best information to be obtained it appears that the year 1889 was extraordinarily dry, while in 1890, in spite of the abundant rainfall the rivers did not fully recover from the effects of drouth. Thus, the published results represent but the minimum condition of the streams, and the water supply in the various localities where measured appears less than is actually the case.

The Montana Division was organized early in 1889, under the charge of H. M. Wilson, who at first devoted his attention to a thorough reconnaissance, especially with regard to storage facilities. After a brief reconnaissance the Upper Sun River Basin was chosen as an excellent field for detailed water storage surveys, and a party was accordingly organized for this work and continued field work until the end of October, 1889. The main reconnaissance lasted from July until October. This preliminary examination was for the purpose of discovering storage sites and determining the relative importance and necessity in the various localities of further detailed engineering surveys. Estimates sufficient for this purpose were made based upon observations by the eye, aided by simple hand instruments.

One of the first regions examined in this reconnaissance was the Missouri River Valley, which begins near Toston on the Northern Pacific, and extends to Cañon Ferry, 18 miles from Helena. It was found that the water supply for the arable land in this tract, which comprises about 60 ☐ of the valley, is abundant and convenient, and may be derived either from the Missouri River by a great canal heading near Toston, or by augmenting by storage reservoirs the discharge from the small streams coming out of the Belt Mountains. Lower down on the Missouri River about 12 miles below the town of Craig are the broad bench lands to the south and west of Great Falls. Here is a fertile and extensive plain known as Chestnut Valley. It is probable that a large canal can be diverted from the Missouri River and brought to the valley at a much higher level than that reached by the ditch now heading at Half-Breed Rapids.

West of Sun River is the great plain through which flow the Teton, Sun and Dearborn Rivers. The perennial discharge from each of these streams is so small that they are scarcely capable of irrigating more than the narrow belt of bottom land bordering them and lying below the general level of the benches. It is estimated, however, that about 920,000 acre-feet of water may be stored if reservoir sites of sufficient capacity can be found. This amount of water would be sufficient to irrigate about 450,000 acres. A number of reservoir sites have already been discovered and some of them examined with detail. The more important of these are a chain of ten sites along the headwaters of the Sun River and on Willow Creek, of which detailed surveys were made.

In the Little Belt Mountains are several areas containing excellent irrigable lands for most of which a partial supply of water can be obtained. Some of the best of these lands were found in the Judith Basin through which flow the Judith River and Willow Creek, Ross Fork and Big Trout Creek. In the upper Musselshell Valley is a considerable area of excellent irrigable land between Martindale and Lavina, a small proportion of which can probably be reclaimed by means of water storage on the Musselshell. The result of the reconnaissance of the great bench lands along the Yellowstone River

leads to the conclusion that a little irrigation can be accomplished by the use of storm waters stored in the streams which flow over it. The main source of water supply for this bench, however, must be sought in the Yellowstone River, which is well worth careful examination and study, but will require extensive detailed surveys before it is possible to decide upon the practicability of diverting the river on to the lands. The average discharge of this stream is such that sufficient water can be brought to the surface of the bench lands to irrigate about 700,000 acres, while with the aid of the water storage at Yellowstone Lake this reclaimable area can be more than doubled.

The Gallatin Valley, in the neighborhood of Bozeman, contains about 220,000 acres of excellent irrigable land, for a large portion of which a water supply can be derived from the West Gallatin River. Along the upper Madison River are several extensive valleys which can be irrigated from that stream, while several storage sites on its headwaters were discovered and reported upon. The water supplies of the Ruby and Jefferson Valleys were examined and storage sites noted on the Ruby River and its tributaries. In the same manner the three agricultural areas of Red Rock, Black Tailed Deer and Beaver Valleys were examined, and it was found that considerable areas of excellent land in these neighborhoods could be reclaimed with the aid of water storage.

The results of the detailed surveys made in the neighborhood of the Sun River show that there are about 395,000 acres of land on the bench between the Sun and Teton Rivers which can be profitably cultivated if a sufficient water supply can be provided. Between Willow Creek and the South Fork of the Sun River are at least 5,000 acres of good irrigable land; while the bottom lands south of the Sun River and east of Fort Shaw, between the Sun and the Missouri Rivers, contain in all about 60,000 acres of excellent irrigable land. Providing a sufficient amount of water can be stored to reclaim this area, the lands east of Fort Shaw can be readily commanded by a canal diverted near that point from the south bank of the river. Detailed surveys and estimates were likewise made which show the feasibility of reclaiming the land between the South Fork and Willow Creek and the great area of bench land between the Sun and Teton Rivers.

The Sun River project as surveyed consists of ten reservoirs whose sites have been segregated. Four of these reservoirs are situated on the Sun River, and must be closed by substantial masonry dams. Their capacities range between 4,870 acre-feet and 30,056 acre-feet. Five of the remaining reservoirs are on Willow Creek and will be filled by water diverted from the Sun River by means of a canal. They will be closed by earth dams, and have capacities varying between 2,091 acre-feet and 36,605 acre-feet. The tenth reservoir is on the bench land and will be filled from the main canal diverted to irrigate this land. It is created by the digging of a simple earth cut to drain a natural lake basin.

Three canal lines were also surveyed in connection with the Sun River project. The first and longest of the three is taken from the north side of the Sun River about a mile below Reservoir No. 1. In all this line was carried a distance of about 66 miles, so as to command the majority of the irrigable lands on the bench between the Sun and Teton rivers. Estimates were made based on a canal 37 ft. in width at the base and carrying 8 ft. in depth of water with a capacity of 1,200 second-feet. Canal No. 2 is taken from the top of Reservoir No. 2, its object being to fill the reservoirs on Willow Creek. As estimated, its dimensions will be about the same as those of Canal No. 1. Canal No. 3 was taken from the bottom of the lower Willow Creek reservoir and will command the 5,000 acres of land between the South Fork and Willow Creek. The line as surveyed will be 11½ miles in length and the capacity of the canal 125 second feet. A fourth canal was projected, but the season was too short for the surveys to be made. This canal will be diverted from the south side of the Sun River near Fort Shaw to irrigate the lands between the Sun and Missouri rivers. Its capacity will be about 300 second feet and its length about 30 miles. The lands to be flooded by these reservoirs were carefully surveyed and have been segregated, their area amounting to 22,190.5 acres.

The Arkansas division was organized in June, 1889, under the charge of Mr. SUMNER H. BODFISH, engineer. This division includes all of the drainage basin of the Arkansas River, though the few detailed surveys made were conducted on the upper headwaters of the river near Leadville. The preliminary surveys were made of eight reservoir sites on the headwaters of the Arkansas, and a detailed survey was made of the Twin Lakes reservoir site. Of these reservoirs the Hayden, Sugar Loaf, Twin Lakes, Leadville and Tennessee Fork sites are the most desirable, but they can, with economy, be replaced by the Twin Lakes sites, since all of the water which they would store can be diverted to this reservoir, the capacity of which is sufficient to contain it. Early in August, 1889, a second party was organized for the purpose of surveying a preliminary line for a canal to divert the waters from the Arkansas River, at a point 10 miles west of the Kansas boundary line, and this line was run eastward and north of the river with a view of irrigating the lands near Syracuse, Kan. Later in the season, this party moved to Monument, Colo., where trial surveys were made of the Monument and Pring reservoir sites on that creek. In the latter part of September Mr. W. W. FOLLETT, Assistant Engineer, was assigned to the duty of making a reconnaisance for the discovery of reservoir sites. He examined and reported on reservoirs on Oil, Wilson, Slate, West Oil, Six Mile, Beaver, Middle Beaver, Seven Lakes, Big Turkey, Oak, Cottonwood and Badger Creeks. He also explored the streams tributary to the Arkansas, between Pueblo Salida, and reported upon 18 reservoir sites, giving for each, in a preliminary way, the dimensions of the dam, recording the general character of the foundation, capacity and the location of the lands to be irrigated.

The Twin Lakes reservoir site was surveyed with much detail. Examinations were made with a view to conducting the waters of the Arkansas River from a point near Hayden station for storage in the Twin Lakes. The catchment area commanded by this canal comprises 285 square miles, which added to that of Lake Creek gives a total catchment basin of 387 square miles tributary to the Twin Lakes reservoir. It has been estimated that the run off from this basin will average 206,400 acre-feet of water. The capacity of the reservoir as surveyed will be about 121,800 acre-feet. The dam proposed for this reservoir will be of earth, 73 ft. in maximum height, paved on the water face with a sufficient depth of rubble and stone to protect it against wave action. The engineering work and preliminary calculations for this dam have been brought as near completion as the hydrographic data would permit. The land covered by this reservoir has been segregated, its total area amounting to 4,716.02 acres. The areas segregated for the remaining reservoirs in Colorado, definite surveys for which were made, aggregate 9,888.98 acres.

In the Rio Grande basin the only project a definite survey of which was made was that of the reservoir above El Paso named Lake Constance. The general results of the engineering and hydrographic work at this point were stated in the first Annual Report of the Geological Survey. It is, therefore, sufficient at this time to state briefly the conclusions. The work as originally designed by Major Anson Mills, U. S. A., was continued to its completion, and the detailed reports and estimates made up by Mr. W. W. Follett, engineer. The dam required to close this reservoir is to be made of masonry and will have a total height of 65 ft. above the river bed. This will create a lake the water surface of which will be about 26,000 acres in area, with an average depth of 26.6 ft. and a cubical contents of 537,000 acre-feet. The estimated cost of construction of a dam at this point is $300,000, to which must be added the cost of removing the railroads, about $590,000, and the cost of damming the flooded land, nearly $69,000, making the total cost, including incidentals, about $1,060,000.

A reconnaissance was made during the winter of the headwaters of the Rio Grande for the purpose of discovering reservoir sites. The principal localities examined were in and adjacent to Mesilla, Albuquerque, Espanola, Taos, Puerco, Jan José, Chama and Jemez valleys in New Mexico and the San Luis valley in Colorado. The results of these examinations bring out strongly the need of storing the flood waters of the Rio Grande and the many natural facilities which its basin possesses for this purpose. It was noted that water is needed not only for land not yet under cultivation but for a large portion of the land which has for years been farmed.

A preliminary examination and report were made of 52 reservoir sites having a combined storage capacity of 2,209,400 acre-feet, for which the water supply is sufficient. The mesa lands which would be reclaimed by the water stored on this river are extensive and well distributed. One of the largest is the Jornado del Muerto, which is about 120 miles in length and 40 miles wide. It is estimated that there are on this mesa 13,000 acres which can be brought under cultivation. There are large bodies of land on the mesa Cuchilla Negra, on the Santa Fé mesa, the Questa, the Tres Piedras mesa and others.

In the California division, under the direction of Mr. WILLIAM HARMOND HALL, supervising engineer, were three parties, one of which was engaged in northern California on reconnaissance work only. The second on preliminary surveys of reservoirs sites in the Sierra Nevadas and a third in making a detailed engineering survey and hydrographic study of Clear Lake in the Coast Range. The Clear Lake party took the field in July, 1889, its object being to make a study of the utilization of the lake basin as a reservoir and to conserve the waters of its drainage basin especially in the hope of regulating its discharge and mitigating the winter floods. The topographic survey was done in the most accurate manner by the plane table, supplemented by the level for closely establishing elevations. In making the hydrographic surveys over 100 miles of traverse lines were run, about 234 miles of soundings were made, and 74 miles of shore line surveyed. A special survey at the outlet of the lake was made in the most accurate manner to determine the location and dimensions of the dam required and of the channel, the bed of which it will be necessary to lower by an outlet cutting about 10 ft. in depth.

The surveys showed that the volume of water contained between the low water plane and a plane 10 ft. below water amounted to 385,300 acre-feet, and the volume contained between low water plane and a contour 10 ft. above low water is 435,300 acre-feet, equivalent to about 19,330 second feet for one day for every one foot in depth in the lower 10-ft. layer and to 21,980 second-feet for one day for every one foot in depth in the upper 10-ft. layer. A careful study was made of the amount of evaporation from the surface of this lake, from which it was found that the annual evaporation exposed at the plane 10-ft. below low water amounts to about 168,000 acre-feet, and from the surface exposed at low water it amounts to about 184,700 acre-feet, and from the surface exposed at 10-ft above low water 208,400 acre-feet.

The field operations of the mountain survey party operating in the Sierras were confined to the several branches and tributaries of the upper Stanislaus, Tuolumne and Merced rivers. This party made seven finished surveys besides doing a large amount of reconnaissance work. Of these, the Little Yosemite reservoir site will require two dams which will make a reservoir having a capacity of 45,000 acre-feet. Lake Tenaiva will be closed by a main and a lateral dam and an embankment, producing a reservoir with a capacity of 23,000 acre-feet. Tuolumne Meadows will require a main dam 75 ft. in height and three lateral dams producing a reservoir of 43,185 acre-feet capacity. Lake Eleanor will require one main dam 65 feet in height, its contents being estimated at 45,770 acre-feet. Kennedy's Meadow, when closed by a 102,000-foot dam, will impound 7,408 acre-feet. Kennedy's Lake, with a 31-foot dam, will impound 2,000 acre-feet, and Bear Valley, which will be closed by a main dam 55 feet high and two lateral dams, will have a capacity of 6,917 acre-feet.

The lands covered by the sites of all these reservoirs and Clear Lake reservoir site have been segregated. The areas of these segregations aggregating 59,486.88 acres.

In the Lahonan Division work was prosecuted during the past year chiefly along the headwaters of the Truckee and Carson Rivers in California and Nevada Three parties were organized in June, 1889, under the general charge of Mr. LYMAN BRIDGES, who was succeeded, however, in this charge by Mr. WILLIAM HAMMOND HALL early in September. Unfortunately none of the work performed by these parties was of a sufficiently detailed character to permit of accu-

rate engineering estimates. The following are the results of preliminary surveys made in this division: A survey was made for a tunnel from Lake Tahoe, the object of which was to conduct the water from that lake through the Tahoe Range of mountains into the Upper Carson Valley. The most desirable tunnel site surveyed was one commencing in Boundary Bay at the mouth of Small's Creek. The project was to start the tunnel at a grade 20 ft. below the surface of the lake and give it a fall of 4 ft. for its full length. An open cutting of 4,200 ft. was projected before the tunnel was entered, the length of this being 13,131 ft. An examination was made into the advisability of constructing an outlet dam at the exit of Tahoe Lake. A water storage scheme known as the Truckee Reservoir Project, which contemplated a dam across Truckee River at a point about a mile above the town of that name was examined as well as a canal line from the reservoir site to the lands of Murtis Valley immediately below the town of Truckee.

A more careful survey was made of Donner Lake reservoir site. Two plans were proposed for the storage of water on this lake; one contemplated a high dam covering the entire Donner Valley and the opening of Cold Creek Valley. This would impound about 42,827 acre-feet of water. The other proposed storage of water in Donner basin alone, and would form a reservoir having a capacity of 22,205 acre-feet. Independence Lake reservoir site was surveyed and the dam site chosen at a narrow part of the outlet valley. The storage capacity of this is estimated to be 23,707 acre-feet. Webber Lake reservoir site would have a capacity of about 11,152 acre-feet. In addition to these, less complete surveys were made for storing water at two reservoir sites lower down on the Truckee Valley, and for building canals to divert the water from the Truckee River to the irrigable lands in its neighborhood.

On the Carson River, Long Valley reservoir site was surveyed with some care. The project included two dams, a main one across Long Valley Cañon and a subsidiary one at Spring Myers, the former 100 ft. in height, the latter 60 ft. high. The total capacity of this reservoir site was determined to be 34,485 acre-feet. Canal lines were also surveyed from the Carson River to fill this reservoir, and also to conduct the water from it to the irrigable lands. Hope Valley reservoir site was surveyed; the dam as projected would have a total height of 153 feet, the capacity of the reservoir being 91,810 acre-feet. The lands covered by these proposed reservoirs have been segregated and their areas amount to 8,523.23 acres.

In Utah in addition to the general reconnaissance of the storage facilities at the headwaters of the Sevier River a careful survey was made of Utah Lake by Mr. F. H. NEWELL, hydrographer. This survey was for the purpose of determining the area which would be governed by the holding back of flood water and the lands included within this area were segregated. The total area of this segregation was 125,440 acres.

The Snake River Division was under the charge of Mr. A. D. FOOTE, engineer, who commenced field work June, 1889. In addition to making a personal reconnaissance at the headwaters of the Snake River in search of reservoir sites, detailed surveys were made with a view of diverting water from the Snake River to the irrigable lands on either side. In the course of his reconnaissance work Swan Valley reservoir site was discovered, which has a storage capacity of about 15 000,000 acre-feet.

Jackson Lake reservoir site, with a capacity of 500,000 acre-feet, and the Falls River reservoir site, with a capacity of 500,000 acre-feet, were also examined and briefly reported upon.

Detailed surveys were made for the Pocatello canal, to be diverted from the south bank of the Snake River near Eagle Rock. This canal line was surveyed for a distance of 100 miles, in the course of which it crossed the Blackfoot and Portneuf rivers. As designed it will have a bed width at its head of 80ft., a depth of 7½ ft. and a capacity of 1,492 second-feet. It will command 216,400 acres of excellent irrigable land. Two canal lines were surveyed from the American Falls, on Snake River, the lower having a total length of 13 miles and the upper of 17 miles. Both of these were discontinued owing to the difficulties of construction encountered.

In the spring of 1890 surveys were made for two canals from Minnidoka Ferry, one to irrigate the lands on the south side of the river in the neighborhood of Goose Creek and Bruneau Plains and the other from the north side with the intention of commanding the country around Shoshone. The north side canal line as run would command a large area of land near Starrhs Ferry, but soon returned to the river, where it encountered difficult work in lava and rock. After running this line for about 35 miles it was decided to be impossible and was abandoned. The south side canal was run for a distance of 35 miles; it was soon found that there was no difficulty in recovering a tract of half a million acres, and possibly more, and with this line completed the south line of the Snake River has been thoroughly explored, as there is no further opportunity for diversion from it.

On the north side of the main river the Snake River Canal line was run from an excellent weir site, two miles below Eagle Rock. This canal covers about 250,000 acres of excellent irrigable land above the American Falls. The canal was further projected below the American Falls so as to cover nearly 600,000 additional acres. The chief objection to the construction of this work is the great length of its line, about 220 miles. The water supply for this system of canals, including the perennial flow of the Snake River during the irrigating season and the storage capacity of the reservoir sites above mentioned, is about 2,850,000 acre-feet, equivalent to about 18 ins. in depth in 100 days over the entire area under command, about 1,730,000 acres.

TOPOGRAPHY.

The work of the topographic branch of the Irrigation Survey was continued throughout the fiscal year in the states of Nevada, California, Colorado, Idaho, Montana and the Territory of New Mexico, under the general direction of Prof. A. K. THOMPSON, chief topographer. The field surveys were mapped to a scale of one mile to the inch, with contour intervals varying from 25 to 100 ft.

In the California-Nevada division the organization consisted of one triangulation and four topographic parties which surveyed 4,850 square miles, chiefly in the neighborhood of Lake Tahoe, and Carson and Reno, Nev. In Colorado the organization consisted of one triangulation, one secondary triangulation and six topographic parties which surveyed and mapped 9,900 square miles. In Idaho one triangulation and two topographic parties mapped 1,900 square miles. In Montana one triangulation and two topographic parties mapped 1,600 square miles, and in New Mexico one triangulation and two topographic parties mapped 3,000 square miles.

In addition to making topographic surveys careful surveys were made outlining the areas of milling and smaller timber, and these areas have been depicted on the topographic maps. In addition reconnaissance examinations and surveys were made of reservoir sites in each of the divisions under survey. In the California division 66 possible reservoir sites were reported, of which 12 were already occupied and 16 contained natural lakes. An account was kept of the irrigable lands included within the areas surveyed and the outlines of the same were indicated by the maps. In Colorado 110 possible reservoir sites were reported by the topographers, of which six are existing lakes. In Montana two reservoir sites were reported by the topographers and a large area of irrigable land outlined on the Musselshell River. In New Mexico 8 possible reservoir sites of considerable area were examined by the topographers, while considerable areas of irrigable land were outlined along the valley of the Mora and Pecos rivers.

The last part of this excellent report consists of a reprint of the testimony of J. W. POWELL, Director of the Geological Survey, taken by the Special Senate Committee on Irrigation. This testimony contains a large amount of statistics and information relative to the prospects and progress of irrigation throughout the world, and is a valuable addition to the existing literature of the subject.

Bessemer's Early Experiments in Rolling Fluid Metal.

In our issue of Oct. 24 we abstracted the technical part only of a recent paper by Sir HENRY BESSEMER on the manufacture of continuous rolls of sheet metal from fluid, iron or steel. The historical introduction to that article, relating how he came to experiment in that direction, how far his experiments went, why he had dropped the subject, and why he had now again taken it up after permitting it to lie fallow for 35 years, we did not then abstract nor refer to, as seemingly of minor interest.

Since that date, however, Mr. R. W. HUNT, President of the American Society of Mechanical Engineers, in his annual address published in our issue of Nov. 28, 1891, has brought out some facts not heretofore made public, and certainly not discoverable in Sir HENRY BESSEMER'S paper, which makes that introduction of much more interest. Mr. HUNT'S exact words may be seen by referring to our issue of Nov. 28. They amounted in effect to a charge of discourtesy and unfairness against Sir HENRY, in that (1) he claimed as his own sole invention a device which he had only made one experiment with 35 years ago, and then dropped, and in that (2) in reviving the subject he did not even mention the name of Mr. EDWIN NORTON, of Chicago, who had taken up and worked out to a successful issue his abandoned idea, though he used Mr. NORTON'S own samples as proof of the practicability of the process. The following is the full text of Sir HENRY'S statement of the facts as to his early experiments, reprinted from his recent paper before the Iron and Steel Association. We italicize certain sentences elsewhere referred to:

ON THE MANUFACTURE OF CONTINUOUS SHEETS OF MALLEABLE IRON AND STEEL, DIRECT FROM FLUID METAL.

Among the numerous inventions that are from time to time brought under public notice, a certain proportion are from some cause or other allowed to fall out of sight and be forgotten. This too frequently happens from some inherent defect or fallacy involved in the scheme itself. It is not, however, always the cause, for some inventions, which appear well worthy of a trial, are never put to any practical test, through having appeared at a time when the state of the particular manufacture to which they apply was not so far advanced as to render the proposal feasible with the then existing state of knowledge, although at a later period, and a more advanced state of the arts, they would at once have been adopted. Hence it has occurred to me that *an invention in connection with the iron and steel manufacture which has quietly slept in oblivion for the last 35 years* might with advantage be discussed at a time when the manufacture of tin plates is occupying so much public attention. I have nevertheless felt much hesitation in venturing on this innovation, which need not be made into a precedent.

Before entering into any details of the method proposed for the production of continuous sheets of iron or steel, it may be interesting to glance briefly at some analogous processes which have been proposed, and in some cases have been carried into successful operation. In doing so the mind naturally reverts to that period when sheets of paper, like our present tin plates, were all made singly by hand. The papermaker with a square gauze wire sieve, dips it into a cistern of pulp, and afterward holds it horizontally above the cistern until the water gradually drains out of it; he then transfers the fragile film of pulp to a surface covered with flannel, on which he leaves it to dry and harden. But the great invention of FOURDRINIER, as improved by DONKIN, has given us a marvelous self-acting machine, having a cistern of pulp at one end, with an endless wire-gauze sieve delivering its film of pulp onto a flannel-covered drying roll, and from thence onto steam-heated glazing cylinders; the machine terminating with a wooden roller, on which an endless web of paper, a mile long, is wound up, fit for any of the varied purposes to which that beautiful material may be applied. This result is accomplished with a rapidity of action, an economy of material, and an excellence of quality that has revolutionized the whole paper trade of the world.

The production of continuous sheets of different materials, direct from fluid or semi-fluid matter, occupied much of my attention a great many years ago; and *as far back as the year 1846, I took out a patent from the production of tinfoil and sheet lead direct from the molten metal.*

The form of apparatus proposed comprises an iron tank, covering the upper part of the furnace. This tank can be used both for melting the metal and for retaining it in a fluid state during the rolling operation. A shaft crosses the tank, and carries a hollow segment of a cylinder; and by means of a screw and wormwheel a slow rotation is given to the shaft, thus slowly and regularly immersing the segment, and thereby displacing and raising the level of the metal in the tank and causing it to flow between a pair of rolls where the metal is chilled, and is converted into a sheet, dependent for its thickness on the distance apart of the rolls, from which it descends on a curved guide plate. The rolls are kept cool by a constant current of water passing through them. I may mention that *this invention was included in a patent for the manufacture of glass*, and, as far as I know, *this particular form of apparatus has never been put to any practical test. I*

may also add that I received, about two years ago, a parcel from America containing a small sample of sheet metal, which was being successfully manufactured there. The person from whom I received it informed me that it was made by a slight alteration or improvement on my patent of 1857, *for rolling continuous sheets and thin bars of iron or steel direct from fluid metal.* He offered me one-half of his patent if I would undertake its introduction into this country. I did not accept his offer, and there the matter rested.

The circumstance stated has, however, afforded me an opportunity of showing you a small sample of a continuous sheet, produced direct from fluid metal at a single operation, and proves beyond doubt or question the important fact that fluid metal may be chilled and formed into a continuous sheet between rolls that are kept cold, *while it well illustrates the spirit of enterprise of our American cousins, who are so prompt to recognize, to adopt, and to improve upon the inventions brought forward in Europe.*

In the year 1846 I commenced a series of experiments on the manufacture of continuous sheets of glass. The first rough experimental apparatus which I used may be described as follows: It consists of a reverberatory furnace, in which a deep bath or cistern is formed, and is used in lieu of the large glass pots previously employed for melting all kinds of glass. The bottom of the bath is sloped or inclined to one side where there is a long parallel opening, having a projecting lip; the lower side of this lip in part overhangs one of the rollers. During the time that the glass materials are being melted the opening is closed with an iron bar resting on the lower lip; on the removal of this bar the semi-fluid glass moves slowly out of the bath; and by the rotation of the rolls is converted into a thin sheet, and then descends the curved guide plate, and is finally received on a horizontal bed.

The rapidity with which a thin sheet of glass passed from a soft and plastic state to one of extreme brittleness is peculiar to this material, and presents a great difficulty in its manufacture, a difficulty which is much increased by the rapidity with which the sheet is produced, and which will be readily appreciated when I state that on one occasion a sheet of glass 70 ft. long by 30 in. wide was produced in about three or four minutes, the first portion having become hard and brittle while the latter portion still retained its plastic state. Fortunately both iron and steel, after passing from the fluid to the solid state, still retain their malleable condition, and give ample time for further treatment before they become cold.

Having thus briefly brought under your notice what has already been accomplished experimentally in the direct production of continuous sheets of lead and glass by the process of rolling, I will pass on to that branch of the subject which is more immediately interesting to the members of this Institute, many of whom may remember that *in August,* 1856, *I first announced to the world the fact that malleable iron in a molten state could be produced rapidly and in large quantities. It is not surprising that I should have at once endeavored to avail myself of the advantages which this novel condition of fluidity presented.* I saw, of course, that like other fluid metals, malleable iron could be cast in molds into any desired form, and reverting to my former inventions for rolling fluid lead and glass into continuous sheets, *I at once grasped the idea that malleable iron or steel could be thus made not only into sheets and plates but also into thin bars or rods, by passing the fluid iron in between a pair of rolls placed in the same horizontal plane.*

I was most anxious to bring to the test of experiment a system so novel, and *so immensely important if successful.*

At the period mentioned I was carrying on a secret process of manufacturing bronze powder at my works at St. Pancras, where I was also making my iron and steel experiments; and in the bronze works I had in daily use a pair of 12-in. chilled rolls placed in the horizontal plane. I saw at once that these rolls would enable me to make such a trial of the scheme as would prove the possibility or otherwise of producing a continuous sheet direct from fluid iron. Unfortunately these rolls were working at some distance from the model converting house, and in a room that was carefully locked and guarded, and into which no strange workmen could be permitted to enter. I therefore had to depend entirely on myself for these experiments. *I employed a common 20-lb. crucible as a converter, and after melting 6 lbs. or 8 lbs. of pig iron in it I immersed the orifice of a fireclay blow-pipe in the metal, which was by this means wholly decarbonized.* No manganese or spiegel was added to it.

I then seized the crucible in a pair of tongs and ran with it into the bronze works. This naturally occupied some little time to accomplish, and when I arrived at the rolls the metal in the crucible had assumed the solid form and could not be poured out. *After several unsuccessful attempts I at last succeeded in reaching the rolls with some fluid metal.* The crucible was lifted on to the back roll and the molten iron was poured in between them. *The rolls were set at about ¾ in. apart, and a thin sheet was obtained some 3 ft. or 4 ft. in length.* The small stream from the crucible did not spread itself far along the wedge shaped space between the rolls, and *as the quantity poured fluctuated a little, so the breadth of the plate increased or decreased in the same ratio, giving an undulating line to the edges of the plate,* some portions of which were afterward rolled to a thinner gage.

The sheet thus produced had a clear surface, almost wholly free from oxidation, and absolutely free from scale. It was as tough as any rolled iron plate I had ever seen; indeed, *it left no doubt in my mind of the entire success of this system of rolling thin sheets direct from fluid metal.*

The thin plate was cut into small samples, and given to different persons. The only relic now remaining of it is a small piece among other early examples of Bessemer metal, contained in a glass case at the offices of the Institute, where this small piece of the original plate may be seen.

So impressed was I with the importance of this invention, that *I immediately applied for and obtained a patent for it, notwithstanding at this particular time the Bessemer process was not merely under a cloud but was regarded by the trade generally as an absolute failure.* One need not, therefore, be greatly surprised that the production of continuous sheets direct from fluid iron did not excite a great amount of enthusiasm in the minds of tin-plate manufacturers of that day; in fact, *the whole scheme was simply pooh-poohed and laid aside without any serious consideration of its merits.*

It is under these circumstances that I have ventured to occupy your time with a chapter of ancient history, in the hope that with the much greater knowledge and skill since acquired in the production and manipulation of mild steel, this system of producing continuous sheets of metal may have the thoughtful attention of those interested in the tin plate manufacture.

I will now describe, in as brief a manner as possible, the apparatus hurriedly secured by patent immediately after this experiment was made. [We omit the description, which is substantially that outlined in Figs. 1 and 2 of our issue of Oct. 24, except as follows.—ED.]

From the foregoing brief sketch of my original form of apparatus, it will be seen that it would be very difficult to supply the molten metal to the rolls with that degree of regularity which is absolutely necessary, while more or less of the slag floating on the surface would be poured out simultaneously with the metal. It will also be observed that in this arrangement of apparatus the metal would fall only on one spot, and if wide sheets were being made it would have to flow lengthwise along the rolls from this one central stream. A further disadvantage would result from the splashing and unquiet state of the metal between the rolls, owing to the great height from which the metal would have to fall from the lip of the large ladle placed high above them.

Having thus freely criticised my first imperfect form of apparatus, I will proceed to explain in what manner I now propose to remedy these defects. These suggested improvements will be readily understood by reference to Figs. 1, 2 and 3, annexed; and here I beg to observe, that I have not gone into the many details necessary for the construction of rolling mills of this description, but have merely given such an illustration of *the general scope of my proposals* as will enable them to be understood.

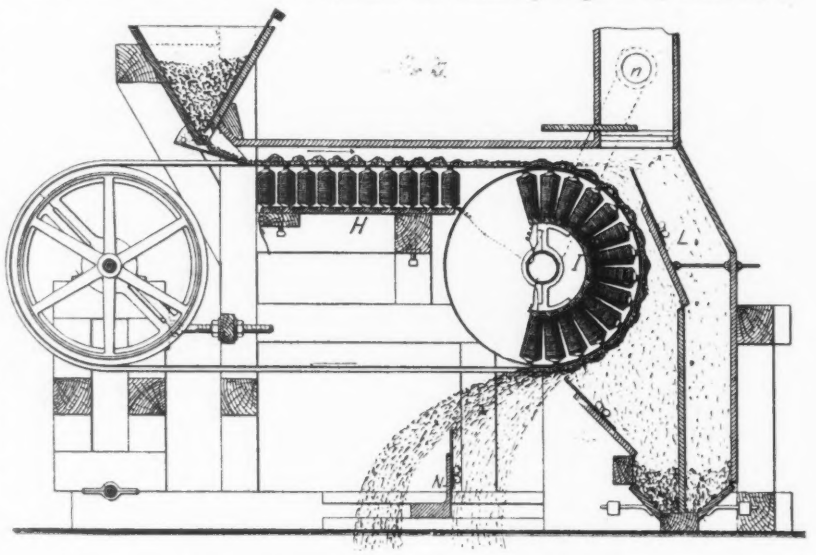
[Here follows the remainder of the paper, as given almost in full in our issue of Oct. 24.—ED.]

The Hoffman Magnetic Concentrator.

In our issue of Oct. 17 we published a paper by Mr. W. H. HOFFMAN, General Manager of the Croton Magnetic Iron Mines, giving results obtained in the magnetic concentration of iron ore in commercial working for a period of 18 months. The paper showed that concentrates were being regularly produced at these mines at a cost of less than $2 per ton, the product analyzing 68 to 70% metallic iron, and .03 to .04% phosphorus. Of this cost $1.13 was for mining, crushing and delivering the ore; about $0.26 was for roasting; and the cost of the actual separation of the ore from the gangue with the magnetic concentrators was only 7 cts. per ton. At that time we were not able to publish the drawings of the separator used to achieve this truly remarkable result, as the patent on it was pending. Since that time however, the patent (No. 463,305) has been issued and we present herewith a drawing showing a vertical section of the machine.

The chief point of novelty consists in the use of a "stratifying magnet" over which the material passes before reaching the separating magnet. The principal difficulties with which the inventors of magnetic separators have had to contend have been, first, the rapid wear of the machines, due to the dust from the ground ore reaching the bearings; second, too great a loss of iron in the tailings; and third, too much objectionable material, phosphorus, silica, &c., in the finished product. The first of these difficulties is overcome by the use of exhaust fans, which remove the dust and prevent its reaching the bearings; but the solution of the other difficulties is not so easy. When a layer of ground ore is passed over a series of magnets, the thickness of the mass causes a difference in the magnetic force in different parts of the layer. If the magnetic force is strong enough to hold the particles of rich ore on the top of the layer, farthest from the poles, it will be so strong that particles which are on the bottom of the layer and close to the poles and which contain but a small percentage of iron will be attracted and will be carried into the finished product, whereas to secure purity of material they should be rejected in the tailings. To obviate this, Mr. W. D. HOFFMAN, Superintendent of the Croton Mines, has devised a system of "stratifying magnets," located beneath the carrier belt just back of the separating drum, shown at *H* in the drawing. Their action is as follows: The ground ore is delivered from the hopper in an even layer upon the endless belt, and passes over the stratifying magnets, which are arranged so that each one is opposite in polarity to the one adjoining. Under the influence of the magnet the particles of rich ore in the material assume positions in the forms of curves extending from the end of one pole to the end of the nearest pole of opposite polarity. At the same time the material is moved along by the belt; and the resulting wave like motion causes the magnetic particles to gather at the bottom of the belt nearest the magnets, while the lighter material, containing little or no iron but most of the injurious impurities, collects on the surface of the layer. It is also claimed that the violent agitation which the ore mass undergoes as it passes over the magnets, causes an effective scouring action which cleans any slightly adherent impurities from the magnetic particles.

Thus stratified, the ore passes along the belt until it reaches the finishing magnets *I.*, which are arranged in semi-circular form on the interior of a drum over which the carrier belt passes. Here the particles are subjected to the attractive force of the magnets, to the force of inertia, under which they tend to fly off at a tangent to the drum, and to a strong air current produced by an exhaust fan in the conduit *n*. The lightest material falls over to the right of the partition *L*. The bulk of the refuse, however, is collected to the left of this partition. As the tailings collect at the bottom of these compartments, they are automatically emptied from



THE HOFFMAN MAGNETIC CONCENTRATOR.

time to time by the weighted gates, enough always remaining, however, to prevent air from entering.

The magnetic particles in the mass stick to the belt until they begin to pass out of the magnetic field, when those containing the smallest percentage of iron detach themselves. The purest particles stick longest to the belt, and the adjustable vertical partition *N* divides the completed concentrate, which falls to the left, from the "middlings," which fall to the right. Formerly the middlings were reground by a separate set of rolls; but the ore is now so uniformly ground by the Sturtevant mills that the middlings are returned by a belt elevator to the feeding hopper of the separator, and are repassed through the machine, so that the final product is either finished concentrate or tailings.

Among other features of interest in connection with the machine is the use of an air blast, which circulates among the wire coils of the magnets and keeps them cool. The carrier belt used is of rubber, with retaining strips on the edges, and is kept tight by adjusting the driving drum at the rear of the machine by a screw gear.

Work on the adaptation of the magnetic process to the concentration of the Croton ore began about three years ago, and several kinds of separators have been used. The Hoffman separator, which we illustrate, has been in use about six months and is reported to be the most efficient and economical separator ever used on the Croton ore. The machine requires very little repairs or renewals. During six months' operation at the Croton mines not a single portion of any of the Hoffman separators has been renewed, nor have they been stopped by the failure of any of their parts. The separators now in use have belts 13 ins. wide, and each has a capacity of 16 tons of ore per bour The power required is 0.75 HP. to drive the machine, and 2 E. HP. to energize the magnets. Larger machines, having a 20-in. belt, are now being built and are expected to still further reduce the cost of separation. The Croton ore is a difficult material to concentrate by the magnetic process, as it requires roasting to eliminate the sulphur, and the ore often comes to the separator at a temperature of 200°. It was at first feared that the rubber carrier belts would not stand this temperature, but they have never shown any sign of injury.

The character of the Croton ore and the resulting product were fully described in the paper in our issue of Oct. 17, referred to above. In general, it may be said that the ore used, consisting largely of refuse dumps from the old works, contains 33% of iron, 0.30% of phosphorus, and 2.5% of silica. For October and November the shipments of concentrates from the Croton Works have averaged: iron, 65.85%; phosphorus, 0.050%; sulphur, 0.67%. The tailings for these two months have averaged 7.67% of iron.

Several samples of ore from different mines are now being tested with a view to the use of this separator in their working. It is also proposed to use the separator to work over furnace slags and reclaim the iron therein.

Disputed Points in Bridge Design.

(*Concluded from page* 612.)

D.—INTENSITIES OF WORKING STRESSES.

We will take the bold step of assuming that in the near future the material for the metal portions of railway bridges will be exclusively steel. This step is warranted by the fact that to-day mild steel is practically as cheap as iron, and that it is fully as reliable.

There is no portion of bridge designing in which there is greater diversity of opinion among authorities than this matter of intensities of working stresses. For this there are two reasons: First, the problem of what is the relation between statically applied loads and the same loads applied with different velocities is practically an unsolved one; and, second, the effect on metal of oft-repeated loads has been experimented upon very extensively, but not in a manner that makes the deductions from the experiments applicable to bridge designing.

The subject of the relation between statically and dynamically applied loads has for years been occupying the writer's mind; and at one time, when in Japan, he went so far as to design and build an apparatus for measuring the extensions of bridge members under loads. Unfortunately, either the design or the manufacture was defective (possibly both), for the instrument failed to give any record of value; and since then no opportunity has been found to continue the investigation. The French technical papers have lately stated that there has been designed in Europe an apparatus for making such measurements by means of water pressure on cylinders of widely varying diameters, and that the apparatus is a success. Here is a fine opening for a series of experiments of the greatest value, and it is not unlikely that, were said experiments made under the auspices of the Americal Society of Civil Engineers, an appropriation to defray the expenses of same could be obtained from the U. S. government. The results of a proper series of tests of this kind would be of incalculable value to the engineering profession. It is probable that the railways would lend their assistance to the extent, at least, of furnishing trains and bridges for the experiments. The series of tests should cover spans of all kinds and lengths, and should be applied also to all the different members of said spans.

Now, as to the wearing effect of oft repeated loads: a number of German scientists have devoted several years to an elaborate series of experiments upon the effect of loading and unloading quite rapidly test pieces of iron and steel beyond the elastic limit. The effect of these tests upon American bridge specifications has been to introduce a somewhat burdensome formula, which is generally of the form:

$$\text{Intensity} = \text{constant}\left(1 + \frac{\text{minimum stress}}{\text{maximum stress}}\right).$$

If the live loads on bridges were applied every two or three minutes, such a formula would be applicable; but in most cases the metal in bridges has time to recover itself between the applications of the live loads; consequently, the adoption of a "fatigue" formula would appear to be unnecessary, involving as it does the use of extra metal.

The adoption of a modification of this "fatigue" formula to cover the effects of both impact and fatigue, is probably, in the present state of our knowledge, the best compromise that can be made; and the writer would consequently suggest that of

$$\text{Intensity} = \text{constant}\left(1 + \frac{1}{2}\cdot\frac{\text{minimum stress}}{\text{maximum stress}}\right).$$

This form of the equation (by no means original with the writer) accords very well with his ideas of what the extreme limits of stress on metal should be. It must be observed, though, that the "Constant" in the equation must be changed for the different kinds of bridge members; as it would be obviously incorrect to make it the same for primary truss members and for the chords of long spans. Moreover, it is scarcely worth while to apply the formula to primary truss members, stringers, floor beams and plate-girder spans under say 50 ft. in length; for in these the item of impact is so much more important than that of fatigue, that, in the limited state of our knowledge, it is well to adopt intensities which we know by experience will be low enough.

The adoption of the formula involving the factor $1 + \frac{\text{min.}}{\text{max.}}$ is surely incorrect, for it implies that a live load is twice as destructive as a dead load. If this were so for one member, it would not be so for another; or, if it were true for short spans, it would not be true for long ones. Let us take, for instance, an extreme case and assume that there are, side by side, two very long duplicate suspension bridges whose cables are iron eye-bars. In one bridge the dead load strains these bars 40,000 lbs. per sq. in., while in the other the dead load strains them to only 20,000 lbs.; but once a day there passes slowly over the structure a live load that strains them 10,000 lbs. more, making a maximum intensity of 30,000 lbs. Now, which of these structures would fail first? Surely it would be that which is loaded constantly to 40 000 lbs.; but the formula would indicate that the two structures under the different loads are of the same strength. Some engineers have even been known to contend that were the live load in the second bridge increased so as to produce a tension of 20,000 lbs. per sq. in., making the maximum intensity 40,000 lbs., the other bridge would still be the one to fail first. This, perhaps, is an extreme view to take; but it would be interesting to try a similar experiment upon a small scale by loading a vertical tension member with a constant dead load that we know, if left on a certain length of time will surely cause rupture, and loading other similar pieces eriodically by loads applied and removed very gradually, producing a series of maximum intensities varying uniformly. If it be desired to obtain results for combined live and dead loads, certain of the test pieces could have dead loads attached that would differ uniformly. To obtain results with any pretension to authenticity, the test pieces should be made alike with the greatest care and of the most uniform metal obtainable, and there should be not less than three pieces used for each different kind of load.

Mr. COOPER, in his specifications for both railway and highway bridges, effectively makes the broad statement that a live load in all cases is just twice as destructive as a dead load. If this be true for a railway bridge where the moving load is applied rapidly and with impact, would it also be true in a highway bridge where the load is applied slowly and quietly? He may reply that he has increased the intensities for highway bridges; but this would be begging the question; for, surely, *the dead load* in a railway bridge is no more destructive than an equal dead load in a highway bridge.

The writer would suggest the following for intensities of working tensile stresses:

Bottom chords and main diagonals (eye-bars),

$$12{,}000\left(1 + \frac{1}{2}\cdot\frac{\text{minimum stress}}{\text{maximum stress}}\right).$$

Bottom chords and main diagonals (plates or shapes) net section,

$$11{,}000\left(1 + \frac{1}{2}\cdot\frac{\text{minimum stress}}{\text{maximum stress}}\right).$$

Long verticals	(eyebars)	10,000 lbs.
" "	(plates or shapes) net section	9,000 "
Short "	(eyebars)	9,000 "
" "	(plates or shapes) net section	8,000 "
Plate hangers		7,000 "
Bottom flanges of riveted cross girders and stringers and longitudinal plate girders over 20 ft. long		10,000 "
Bottom flanges of stringers and longitudinal plate girders of 20 ft. length and less		9,000 "

The principal object in reducing the intensity for flanges of girders not exceeding 20 ft. in length is to discourage the use of short panels.

It is proper to use the same formula for bottom chords and main diagonals, because the minimum stress in the former is the dead load stress, while in the latter it is the dead load stress less the live load stress that tends to put the diagonal in compression. When counter ties are used, of course there can be no such reversing stress in excess of the dead load stress, hence the minimum stress will be zero, and the proper intensity of working tensils strength will be 12,000 lbs. for eyebars and 11,000 lbs. for plates and shapes. For counter rods, the writer, when he cannot avoid adopting them, still perfers to use iron, and to strain them 8,000 lbs. to the square inch.

BUILT TENSION MEMBERS VS. EYEBARS.

Some engineers contend that, *for steel*, tension member built of plates and shapes are as strong, per square inch of net section, as are eyebars; but until ample experiments prove this to be a fact, the writer perfers to make a difference for the two cases, although not so great a difference as he would adopt were the metal iron.

For top chords the intensity recommended would be

$$11{,}000\left(1 + \frac{1}{2}\,\frac{\text{minimum stress}}{\text{maximum stress}}\right)$$

unless the ratio of unsupported length to least radius of gyration exceed 50, in which case the intensity given by the formula is to be multiplied by the quantity $\frac{50}{\text{ratio of } l \text{ to } r}$. In most cases of well designed railway bridges the ratio of l and r is less than 50. Some engineers are of the opinion that top and bottom chords can be strained alike, especially if a slightly higher grade of steel be adopted for the former, but the writer will be averse to this until experiments upon full sized compression members prove it to be legitimate.

For inclined end posts the intensity of working stress should be found by the same formula as used for top chords; but in nearly every design for through bridges it will be found that the bending effect of the wind pressure will necessitate an increase of section. For vertical posts, which should always be hinged, the intensity can be found by the formula, $p = 12{,}000 - 60\,\frac{l}{r}$.

This formula was given to the writer some five years ago by Mr. EDWIN THACHER, who established it in an eminently practical manner by plotting the results of a large number of experiments, inclosing the points by an oval and drawing an axis through the latter. The equation to this straight line, divided throughout by a certain factor for safety, will give the last equation. The writer wishes to protest here against the further use of $\frac{l^2}{r^2}$ in formulas for compression members, for the reason that it involves unnecessary labor and gives results that are no more nearly correct than those obtained from formulas involving $\frac{l}{r}$ to the first power. The general use of the second power is due to its having occurred in EULER'S formula, which was established upon an assumption that does not hold good for compression members of bridges. Some engineers may contend that it is immaterial whether $\frac{l}{r}$ be used to the second or first power, as the results are always tabulated; but there are so many slightly different formulas specified which involve $\frac{l^2}{r^2}$ that one often finds that the tables he has at hand will not apply.

For lateral struts, the ends of which should always be fixed, the formula will be $p = 17{,}000 - 55\,\frac{l}{r^2}$.

This formula may appear to give too great intensities; but it will be found that the limiting sizes of sections and limiting ratio of length to least dimension, which are given in good specifications, will overrule the objection; and when designing the lateral systems of large and important bridges, the computer who tries it will become convinced that this formula is just what he needs.

In cases of very great wind pressures for long spans, where it takes a large amount of metal to provide for wind stresses, the writer considers it legitimate to adopt

a double system of triangulation for the lateral system and to assume that each half carries one-half of all the wind pressure allotted to the entire system; and in so doing he is not inconsistent, although condemning multiple systems for vertical trusses; because maximum wind loads are of rare occurrence, while the maximum loads for vertical trusses are liable to occur frequently.

Referring to the latest edition of Mr. THEODORE COOPER'S specifications, the writer wishes to take exception to a couple of points relating to strut formulas. First, the intensities specified for posts are excessive; for instance, in the case of a long span where, on account of the inclined top chords, the dead load stresses in posts are so small that we may here ignore them (if in fact they do not reverse), his formula for steel would be about $8,400 - 48\frac{l}{r}$. If $\frac{l}{r}$ be assumed equal to 80, which is allowable, the intensity of working stress would be only 4,560 lbs. Surely this is too small for such a large and important member as a vertical post. Or, if we assume $\frac{l}{r} = 50$, the intensity will be 6,600 lbs., while according to Mr. BOUSCAREN'S specifications it would be 12,000 lbs. Surely when two such high authorities differ to such an extent, some explanation is needed. The writer's proposed formula would give an intensity of 9,000 lbs., which is exactly a mean between the two.

Second, the writer considers it to be incorrect to treat a batter brace or inclined end post in the same way as a vertical post is treated; for said batter brace is in some extreme cases merely a continuation of the top chord, and in all cases resembles the same in respect to stress and sectional area. Therefore it ought to be treated as such.

It is hoped that Mr. COOPER will explain in the discussion his reasons for specifying such peculiar intensities of working compressive stresses as those referred to.

Finally, a word in regard to the use of the formula for reversing stresses, viz.,

$$p = \text{constant } 1 - \left(1 - \tfrac{1}{2}, \frac{\text{minimum stress}}{\text{maximum stress}}\right)$$

This should be employed where the reversion is of common occurrence, as in web diagonals, and not where it is unusual, as in the flanges of floor beams where the stresses are liable to be reversed once in a great while by highway loads carried on cantilever brackets.

E.—CONTINUED STRESSES

We will divide this into two parts: 1st. Longitudinal stresses only; and 2d. Co-existent longitudinal and bending stresses.

Part No. 1 relates principally to bottom chord proportioning when the wind stresses are taken into account. One authority stipulates for this, that when the wind stress exceeds ¼ of the sum of the live load and dead load stresses, the section shall be increased until the total stress per square inch will not exceed by more than 25% the maximum fixed for the live and dead loads only. The writer would prefer, after figuring the direct and indirect wind stresses as explained previously in this paper, and adding them to the sum of the live load and dead load stresses, to use an intensity 40% greater than that adopted for the live and dead load only, provided that said intensity never exceed 21,000 lbs. for eyebars, or 19,000 lbs. for tension members built of plates and shapes. It is better to take into account all possible stresses when finding the maximum total, and to use a high intensity, than to ignore certain important stresses and use a lower intensity.

Part No. 2 relates principally to the proportioning of batter braces or inclined end posts; and it is a peculiar fact that no railway bridge specification yet written begins to cover the ground of designing properly this important member of a through bridge; and, moreover, the matter is seldom given the importance it deserves, even in large bridges designed by our leading bridge companies and by expert engineers. There are three vital considerations in the correct proportioning of batter braces, viz.:

A. What are all the direct stresses, and how are they to be found?

B. What is the greatest bending moment, and how should it be computed?

C. What are the proper intensities to be used, and upon what should they be figured?

The answers to these questions are as follows:

A. Live load, dead load and transferred load stresses, the latter being computed as indicated previously in this paper.

B. The greatest bending moment is found by assuming a division (usually equal) of the total wind pressure upon the structure between the four pedestals, and multiplying the thrust on one leeward pedestal by the distance between the center of the end pin and the section of the batter brace under consideration. Some engineers, in order to reduce the bending moment thus found, which is undoubtedly very great, assume a fixedness of the batter brace at the pedestal, thus cutting down the length of the lever arm, and consequently the amount of the bending moment, by 50%. Although the writer some seven years ago computed in this way, he is now convinced that the method is wrong; for the end of the piece cannot possibly be fixed or held in any way that even approaches fixedness. At the moving end of the span there is certainly enough play between the bottom of the pedestal and the holding down members, whatever they may be, to nullify all assumptions of rigidity; while at the other end of the span, even if there were no play in the end pin hole, the anchor bolts and the details affected by the stresses therein are by no means strong enough to warrant one in assuming the connection to constitute a fixed end.

C. The intensity of working stress is the total intensity on the extreme fiber of the section considered, and is equal to the sum of the total direct stress divided by the sectional area of the member at the place considered, and the intensity of extreme fiber stress on the compression side, due to the bending moment of the horizontal reaction at the foot of the member. The value of this total intensity should lie between 20,000 lbs. for short spans and 24,000 lbs. for very long ones. Even these apparently high values will often make the sectional area of the batter brace appear excessive.

The most effective way to strengthen the batter brace against bending is to add metal in the form of heavy angle irons just outside of the webs of the built or rolled channels. A number of the latest Missouri River bridges, all built by the same engineer, show a quite unnecessary defect in the design for the reinforcement of the batter brace; for all of the reinforcing metal is placed upon the inside in the form of a built I beam, thus making the section of the member decidedly unsymmetrical, and weakening instead of strengthening it.

In one of these cases which the writer has checked, the addition of 16.85 sq. in. of section in the form of a built I beam *increases* the intensity of working stress for combined live and dead loads about 18%; while, if the same area had been added symmetrically, the intensity of working stress would have been *reduced* about 26%. It is true that the member as it stands is all right for bending, even with the worst combinations of stresses, and the metal under live and dead load stresses is not dangerously overstrained; nevertheless, there seems to be no good reason for disposing of extra metal so unscientifically as to make it do more harm than good, when it could easily have been distributed advantageously. Possibly the reason is that if the extra metal were divided equally between the two sides of the member, the leeward batter brace would, for combined direct stress and bending, be strained about 10% higher than the windward batter brace with all of the metal on the inside; but even then the extreme fiber would still be strained within legitimate limits. Moreover, is it not better practice to overstrain metal once in a great while, say once in 10 years, by 10% than to overstrain it 18% every time that the structure receives its full live load?

F.—PLATE GIRDER PROPORTIONING

In this matter there is quite a little difference of opinion among bridge designers, probably owing to the necessarily unsatisfactory character of all investigations concerning stress distribution in this style of girder. Plate girder proportioning amounts to but little more than rule of thumb practice; so it would be well for us all to acknowledge the fact at once, and by a series of experiments to destruction, ascertain how satisfactory are our present methods of design; then, if necessary, modify them.

The questions of how the shear on the web travels, and how the stress on a flange distributes itself over the section, can never be determined analytically except upon assumptions that cannot be verified even approximately, nor can we tell by theoretical investigation what should be the proper thickness for a web; consequently it would be well to drop these investigations at once and for all time, and content ourselves with ascertaining whether our present methods of proportioning will bear the searching investigation and criticism attendant on exhaustive experiments. In the writer's opinion, any web, *if properly stiffened by angle irons* of an economically designed plate girder, will have sufficient sectional area as far as strength is concerned, so there is no use in adopting webs thicker than ⅜ in. for long, deep, single track girders, provided that said thickness give ample bearing for flange rivets near the ends of span, which in most cases it will.

As a matter of precaution, the writer is averse to making webs of stringers less than ⅜ in. thick, although he believes that ⅜-in. plate, when effectively stiffened and kept well painted, will do its work just as well. Does any one know of a case where the ⅜-in. web of a well designed plate girder was the cause of even symptoms of failure? Some statistics on this point, and on points of actual weakness of plate girders under traffic, would be very interesting, and it is hoped that the discussion on this paper will bring such matters to light.

The clause in Mr. COOPER'S specifications which stipulates that, whenever practicable, half of the sectional area of any flange should lie in the two angle irons is a very good one, and in the writer's opinion the number of cover plates used for a flange should be restricted to 3, or preferably to 2.

There is an important matter neglected in most railway bridge specifications, viz., the proportioning of end stiffeners where the plate girders rest on masonry or other supports. The intensity to use for the steel end stiffening angles should be 8,000 lbs.; and the filling plates, if there be any, should not be counted upon as aiding said stiffeners. Both ends of such end stiffeners, and the upper ends of all intermediate stiffeners of deck girders, should be cut so as to bear against the horizontal legs of the flange angles. This a point often overlooked in manufacturing.

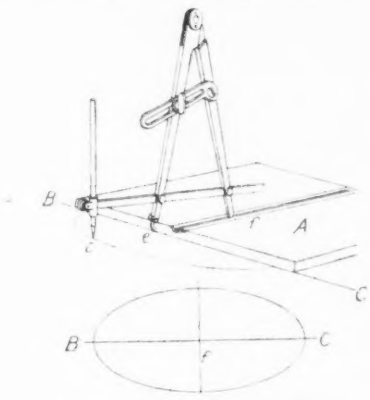
There is some difference of opinion among experts as to the greatest allowable length of unsupported compression flanges of plate girders, Mr. COOPER placing it at 30, and others as low as 20 times the width of the flange. The writer thinks that with the style of floor system described in this paper, where the track ties provide great lateral stiffness for the flanges, the limit of 30 is correct.

It is his firm opinion that the proper way to proportion the section of a plate girder for a given bending moment is to count in the web as aiding to resist bending. It surely does aid in resisting, so why not allow for its resistance? There is no need for going into burdensome calculations involving moments of inertia of cross section, when the method of assuming that ⅓ of the area of the web is concentrated at the center of gravity of each flange will give almost identical results. Of course, if the web be counted in, the intensities of working stresses for the flanges will have to be decreased accordingly. While it is true that for girders of ordinary proportions it is immaterial whether the flange section be proportioned by one formula, ignoring the web, or by another equivalent formula involving it, it is evident that in girders of unusual proportions, for instance, very deep floor beams where the bending moments are comparatively small, the ignoring of the aid of the web in resisting bending causes a waste of metal in the flanges.

The paper closes with a number of suggestions as to "General Details of Construction," which we omit.

A New Form of Ellipse Compass.

We find in the *Schweizerische Bauzeitung* a description of the compass for drawing ellipses shown in the accompanying illustration, which seems to have some novelty and merit. Like most compasses of this sort, it utilizes a well known property of the ellipse as follows: The major axis of the system of co-ordinates is represented by the edge of the board *A*, while the minor axis is represented by the groove *f*. The compass being set as below described, one point of the compass is caused to glide along the edge *B C*, and the other in the groove *f*. The pencil point *e* then describes on the paper underneath one-half of an ellipse. By turning the paper or the board around, the other half can be drawn in a similar way. The opening of the compass gives the eccentricity, the position of the pencil holder the size of the ellipse. The groove *f* is carried a little beyond the board and closed up for the practical purpose of enabling a full half ellipse to be drawn. The bent point *e* easily glides past this protuberance. In place of the pencil *e* a ruling pen may be substituted. The patentees of this compass are Messrs. GUGOLZ and HOFMANN, in Zurich, Switzerland.



A Compass for Drawing Ellipses

Indian Railways.

From the recent report of the Director General of Indian Railways we extract the following résumé of the main results of the past four years' operation:

	1890.	1889.	1888.	1887.
Miles open (mean).....	16,228	15,758	14,459	14,068
Gross earnings per mile.	$6,360	$6,500	$6,830	$6,570
Passenger per mile.....	7,630	7,193	7,174	7,027
Tons per mile.....	1,393	1,446	1,557	1,487
Aver. passenger haul...	42	42	42	42
Average freight haul....	153	164	159	158

The per cent. of expenses to earnings has been nearly constant at 50%. The rate of extension has for 10 years or more been nearly constant at 800 to 900

miles. Of the present mileage 60% is 5 ft. 6 ins. gage and 37¼% metre gage, the remaining 2½% being irregular.

The average passenger rates are the lowest in the world, as also the standard of comfort for passengers. The average is only 0.71 ct. per mile; for the first class the fare is 2.9 ct.; second class, 1 ct.; third and fourth class, 0.6 ct., the last two classes constituting 97⅛% of the traffic. The earnings per passenger train mile were $2.52. The average number of passengers per train ranged between 302 and 158, the last being the lowest on any Indian railway, and being nearly four times the English and American mean, 42.

The average rate per ton mile was 1.76 cts. in 1890, against 1.66 cts. in 1889, a very low rate, all things considered, and much lower than the average of any European country. It is explained, however, by the very long average haul as above given. The average earnings per freight train mile were $2.07, from which it would appear that the average freight train load is nearly 118 tons, not a bad showing in comparison with European railways, though much below American practice under similar conditions. The average yearly mileage per locomotive is only 10,000, which shows poor management. The employés (96% being natives) number 16.2 per mile, against 17.5 in this country. The accidental deaths last year were 454, 43 being of passengers. The distribution of operating expenses is very nearly the same as in this country. Maintenance of way absorbs 27% to 28%; of cars, 8.7% to 9.6%; of locomotives (including engine wages and fuel) 31½% to 32½%.

The Proposed Siberian Railway.

The length and cost of this proposed great railway, nearly all of which has now had a preliminary survey, is officially stated as follows:

Name of section.	Length in miles. Main l.	Branches	Total.	Cost to sub-grade per mile.
1. Miask-Chelyabinsk	62⅖	.....	62⅖	$16,025
2. Chelyabinsk-Obi, with branches to Omsk and rr. Tobal, Eshim, Irtish and Obi	970*	50*	1,020*	9,460*
3. Obi-Irkutsk, with branches to Tomsk and rr. Tom, Yenisei and Angara	1,100	60	1,170	16,720
4. Irkutsk-Misova	195⅕	.....	195⅕	35,840
5. Misova-Stretyinsk	667⅕	5⅕	672⅖	21,095
6. Stretyinsk-Graffsky	1,600*	.....	1,600*	23,525
7. Graffsky - Vladivostock	256	6	262	25,260
	4,861⅕	121⅕	4,982⅖	$19,200

The aggregate estimate is nearly $143,500,000 to sub-grade, to which is to be added over $9,300 per mile, or nearly $70,000,000 in all, for track and rolling stock. This estimate covers the cost of permanent bridges over six great rivers. It is required that all the material shall come from Russia. It is expected to finish section 7 in about 3 years. Section 6 is still unexplored, but will be surveyed this year. Section 1 has been located and is under construction. The remaining sections are still liable to material changes.

The question of employing Chinese labor has been raised, but the Ministry seem to think that the competition with Russians would create a feeling better avoided, and an order has been issued (April 20) that the convicts are to do the work, receiving one-tenth of the determined rates of pay, the balance to be expended in looking after them.

The width of the embankments is to be 16 ft. 9 ins.; in cuttings the slopes will depend on the nature of the soil; the rails are to be 48½ lbs. per yd.; sufficient rolling stock is to be kept for 2 mixed trains and 4 goods trains daily. The line is built especially to facilitate the transport of troops from the Amur to Vladivostock, and the termination proposed at this port is considered by the military authorities to be too open to attack from the sea, so that it is still a point in dispute whether Nikolsk, a valley further inland, should not be chosen for the terminus.

The great question as regards the Siberian railway in general is whether the line is to be for transit or to serve local interests, and it is evident that only valuable merchandise could be carried such long distances by land; grain and such goods would still go by water where possible. But nobody pretends that the railway is primarily for commercial purposes; it is to serve the state, and is as necessary as keeping up a standing army in Europe. At present it takes 18 mos. to transport troops from the Volga to Vladivostock over Siberia, whereas by rail it would be a matter of 30 days.

The climate is a matter of serious consideration. Frost is not supposed to go into the ground more than 7 ft.; but where tested round the Baikal sections, at a depth of 10 ft., the soil has been invariably found frozen hard. Thus the foundations of structures would be on frozen soil. Along the whole line the temperature for days at a time is sometimes −40° F., and in some parts lower than −60° F. The averages for the middle of January recorded at Chelyabinsk −1°, between Omsk and Baikal −2° to −8°, beyond Baikal −13° to −26°, on the Usuri from −21° in the north to +70° at Vladivostock. The lowest temperature ever recorded was at Irkutsk on Dec. 17, 1860, 67° F. below zero, but on Dec. 15 the thermometer stood at +12°, while on Dec. 4 it was actually 36° F.

It is intended that the level of the railway shall, including ballast, never be less than 3 ft. 9 ins. above the plains; and as protection portable hurdles will be fixed, and larch trees planted along the lines as these grow well and quickly. The roadbed is to be 15 ft. 6 ins. in hilly country, and 16 ft. 9 ins. in ordinary parts; the gage will be of the width usual in Russia, 5 ft.

We abstract these details from an elaborate paper on the railway, by Mr. W. M. CUNNINGHAM, Assoc. Inst. C. E.

Anchoring Bolts in Stone.

Experiments in this line are recorded in the Troy *Polytechnic*, practically as follows: As a suitable test, 14 holes were drilled in a ledge of limestone rock, all 42 in. deep, and bolts, some three quarters and others one inch, were set in the holes; around four of these bolts, sulphur was then poured, lead was put in around four more, and Portland cement, well mixed, around the others. Two weeks later the bolts were pulled by a powerful lever, and, out of those run with sulphur, one was drawn out under a strain of 12,000 lbs., with the others the iron yielding before the sulphur gave way; three of the bolts calked with lead also broke in place, one pulling out; but of those set in cement one yielded slightly and then broke, while all the others broke in place. The tests made under these circumstances are regarded as fairly demonstrating that Portland cement is not only cheaper for setting iron into stone, as well as less likely to corrode the iron, but is stronger and much more easily applied.

The Compressive Strength of Brick.

In our issue of Dec. 12 were published the results of tests recently made at the Watertown Arsenal on the compressive strength of bricks made by the Chicago Hydraulic Press Brick Co., of Porter, Ind. These tests showed an ultimate strength of 95,000 to 170,500 lbs., or 2,860 lbs. to 4,973 lbs. per sq. in. The average was 3,972 lbs. per sq. in.

On Dec. 1 a test was made at the Watertown Arsenal on a "fancy pressed brick" made by the National Brick & Tile Co., of Bradford, Pa. The test as before was made with the brick placed flat, and the compressed surfaces faced with plaster-of-paris to secure even bearings in the testing machine. The brick measured 8.12 × 4.03 ins., having a total face area of 32.72 sq. ins. The first crack developed at a pressure of 305,000 lbs., and the brick crushed at 364,300 lbs., or 11,130 lbs. per sq. in. We are not informed as to the process by which this brick was made and its treatment in the kiln. It is of interest to note in this connection that the compressive strength of granite paving blocks is only 12,000 to 20,000 lbs. per sq. in.

We also note in this connection a test of four bricks reported by Prof. R. C. CARPENTER, of Cornell University in the last number of *The Clay-worker*. The bricks were from clay obtained near Ithaca, and were made on an "angle" brick machine, No. 1 being afterward repressed on a hand press. No. 2 was burned until it was partially vitrified. No. 4, which showed the least strength, was made from surface clay. In testing the bricks were placed on edge, not flat, as in the tests above. The sides were dressed on an emery wheel to give parallel faces; and a sheet of thick paper was placed between the brick faces and the plates of the testing machine. The crushing strength of Brick No. 1, Prof. CARPENTER believes to be the highest of any brick on record.

No. of brick	1	2	3	4
Specific gravity	2.18	2.01	1.91	2.07
Area of side, sq. ins.	16.95	18.5	18.5	17.92
Width of brick, ins	3⅜	3⅞	4	3¾
Stress at 1st crack, lbs.	208,000	84,000	56,000	48,000
" " " lbs. per sq. in.	12,230	4,580	3,508	2,600
Stress at crushing, lbs.	254,000	172,000	180,000	141,240
" " lbs. per sq. in.	14,990	9,309	10,909	7,880

A Pipe Line Laid with Mannesmann Tubes.

A communication of Mr. W. SIEMENS to the Verein für Gewerbefleiss, given in *Dingler's Polytechnisches Journal*, gives the following information in regard to the use of the remarkable Mannesmann tubes for a pipe line to pump petroleum from Baku westward. (See ENG. NEWS, Dec. 12, 1891). The process of manufacturing these tubes by the paradoxical process of exterior rolling in a solid ingot, which causes it to expand into a tube closed at both ends, was fully described in our issue of Aug. 2, 1890, &c.

Experience with the pipe line shows that the material thus worked is extraordinarily homogeneous and reliable, so that the finest screw-threads can be cut on the tubes with ease. They are cut conically, so as to give a perfectly tight-fitting joint. It was found that under a pressure of nearly 90 atmospheres no leakage of any kind occurred in the whole conduit, 14 miles long. The sleeve is simply half screwed on the connected pipe and the next pipe screwed to the former. The seamless tubes are easily bent into small circles. This remarkable attribute was made use of by bending them into spirals for expansion connecting pieces; those have about 2 ft. 5½ ins. diameter, while the tubes themselves have an inside diameter of nearly 4 ins. Threads are cut in the ends of those spirals, which are connected with the straight tubes in the way described. Any angle can be turned while still providing for expansion by inserting such a spiral. As there are not many obstacles encountered, the conduit lies for the most part in a straight line. At the start each kilometre (0.621 miles) of the whole length was fitted with two of these spirals, in order to provide for the expansion and contraction of the conduit, caused by the atmospheric changes; but afterward only one was employed. Perhaps even that was unnecessary, as no such device is used on our pipe lines in this country, but it illustrates the quality of the pipes that it should be possible to treat them in this way.

In our own pipe lines the only provision for expansion which has been found necessary is to lay the pipe in very long, flat, reversed curves, which in connection with the surface irregularities is found to answer all purposes. Doubtless the temperature strains in the metal are greater by this process than when complete spirals are used, however.

A New Refuse Destructor.

The London *Architect* gives a description of a new refuse destructor which the Aston, Eng., Local Board purpose erecting at their sanitary depot, Chester St., at a cost of some $30,000, the engineer being Mr. W. A. DAVIES, surveyor to the Local Board. The refuse is put into the destructor, and it contains sufficient refuse coal and other combustible material to keep the furnaces going when once lighted, no other fuel being necessary. The temperature of the furnaces ranges from 400° to 1,000° Fahr., according to the firing; and considerably less heat than the lower is sufficient to effectually destroy any germs of disease, and to consume the injurious products of combustion before they are passed into the open air. Patent fume cremators are also provided through which all gases from the furnaces pass over a fire the temperature of which sometimes reaches 1,500° Fahr., from which they are conducted into a chimney shaft 160 ft. in height. The intense heat, which it is estimated will be sufficient to develop 45 HP., will be utilized for driving machinery and generating electricity, and in dealing with the clinker or residuum which will be left after the burning. This residuum can be ground up for concrete mortar, or made into paving blocks, or used in the construction of streets, and a suitable boiler is provided in the main flue of the destructor. The amount of house refuse, street sweepings,

&c., to be disposed of is 30,000 loads per annum. Part of this can be carted to tip, and about 10,000 loads can be sold to farmers for the land. Each of the 8 cells of the refuse destructor, it is estimated, will burn from 8 to 9 tons per day of 24 hours, and the 8 cells should burn, if properly stoked and attended to, about 22,000 tons per annum. The works consist of the 8-cell destructor, roofed over, and in connection with the same is Jones' patent fume cremator. An inclined approach for the carts to be drawn up to discharge the refuse on the top of the furnaces, which are 14 ft. above ground level and fed from above, will also be provided.

The Compressed Air Supply of Offenbach.

This industrious little town is near Frankfort-on-the-Main, where the International Electrical Exhibition is now in progress. It has just completed and started an interesting air supply, similar to the much larger enterprise at Paris. This is the first town in Germany where an arrangement of this kind has been inaugurated, and the air is chiefly used for small motive powers. The work has been executed by the firm of A. RIEDINGER, of Augsburg, and they have now, we believe, in hand the erection of another complete plant for a town in Switzerland. At present there are about 23,000 ft. total length of cast iron main with 26 valves, about 5,000 ft. of 1 ft. diameter, 5,000 ft. of 3 ins. diameter, and 13,000 ft. of 4 ins. diameter. The joints are all made with india rubber rings. This network of pipes, after being laid in the streets, was tested with the following results: With a pressure of 6¾ atmospheres kept up for 70 hours, the loss per hour was only 1.99 cu. m. or 0.028 cu. m. per hour per kilometre. The pumping station is a handsome building lighted by electricity, and containing the steam compressors, boilers, air reservoirs, &c. The air compressor is kept up to 6 atmospheres. The steam engine is of the compound horizontal side-by-side type. It is condensing, and has two cranks with a flywheel between them. The steam expands, as usual, in two cylinders, but the novel feature is that the air is compressed in two other cylinders, which are placed tandem, one after each steam cylinder. The first compresses air up to 2 atmospheres, and the second completes the pressure up to 6 atmospheres. A special arrangement cools the air in the cylinders and in the receiver between them, by means of water jets. The efficiency of the whole machine is estimated at 87%. The steam cylinders are about 22 ins and 32 ins. in diameter by 3.28 ft. stroke; the air cylinders are about 16 ins. and 24 ins. in diameter, and have the same stroke, as each air piston is worked direct by rods from the back of the corresponding steam piston. The engine is said to consume 15½ lbs. steam per indicated HP. per hour. The most remarkable feature is the high speed attained by the air pumps, viz., 75 revs. per minute, or equal to 490 ft. per minute. Altogether it is a most complete and interesting installation.—*Engineering.*

The Lauffen Water Power.

The available water power for the turbine plant of the Portland Cement Works at Lauffen, on the Neckar, a part of which is now being used to supply the Frankfort Electrical Exposition, has a fall of 12.5 ft. (3.8 meters), according to *Dingler's Polytechnisches Journal*. The flow of water is 10,000 to 11,100 galls. per second, and furnishes thereby an absolute amount of 2,000 HP., of which, assuming 75% efficiency of turbines, 1,500 HP. can be utilized. Of this 1,296 HP. are taken up by 5 turbines. Two combination turbines, each with 2 wheels, of 608 HP. in all, furnish power for the cement works. One turbine of 80 HP. serves to light the town of Lauffen and the cement works, and also furnishes power for electric elevators. Another is intended to furnish light and power for the town of Heilbronn in the near future. The fifth feeds a dynamo of about 300 HP., which transmitted power to the International Electrical Exhibition at Frankfort-on-the-Main, by a method now famous. Power is transmitted direct to the dynamo by a bevel gear, so that with 35 revs. per minute of the turbine the dynamo makes 155.

THE INTER-CONTINENTAL RAILWAY reports progress to Dec. 18, through the Executive Committee, as follows: Corps No. 1, under Capt. N. M. MACOMB, has surveyed three lines through Guatemala, from the Mexican boundary to Guatemala City. One line follows the coast; the second is through the coffee district, and the third goes through the highlands in the interior. Corps No. 2, under Mr. WM. F. SHUNK, started at Quito, in Ecuador, and had surveyed a line northward as far as Pappegan at the head of the Cauco River. They are bound for Panama. Corps No. 3 started under J. IMBRIE MILLER, but as illness caused Mr. MILLER'S return to the States, the party is now in charge of Mr. KELLY. This corps worked from Quito south, and has reached the boundary of Peru, a distance of 450 miles. They will survey along the Maranon River to Cerro de Pasco, the terminus of the new Oroya Railway. Next summer another corps will continue the survey through Bolivia to a connection with the new Brazilian line leading to Rio Janeiro. So far no very great engineering difficulties have been encountered on these several lines.

THE INTRAMURAL TRAFFIC OF CHICAGO is under consideration by a committee of street railway and city officials. The first problem to be considered is that of temporary relief, and various plans will probably be presented. The problem of permanent relief by increased facilities will be taken up later. The following recommendations have been made by a committee of the Taxpayers' Association: During the "rush" hours, morning and evening, the number of cable trains should be increased to the full capacity of the loops, and the number of horse cars should be increased, so far as can be done without interfering with cable lines at crossings and on common tracks. Short trip cars should be run on routes extending 2 to 2½ miles from the center, and they should be run on separate routes, wherever such can be found, so as not to interfere with the through cable lines. Means should be taken to enforce speedy completion of the two elevated roads now partially completed. The principal railway lines running into the city should be induced, if possible, to elevate their present passenger tracks, and should be urged to increase the accommodations which they now afford to suburban traffic, by running frequent and rapid trains, making half-mile stops.

AMERICAN IRON SHIPS of the highest class, it is alleged by Mr. CHAS. H. CRAMP, the famous shipbuilder, can now be built in America at as low prices as on the Clyde, the Mersey or the Thames. He will contribute to the January number of the *North American Review* an article maintaining this position, and supporting it with many facts from his experience and knowledge.

THE HEIGHT OF BUILDINGS IN CHICAGO will be practically limited in future by the recent decision of the Chicago Fire Underwriters' Association to charge a high rate of insurance on buildings beyond the limits fixed by the Association. The resolution passed was to the effect that the height of all office buildings of fire-proof construction should not be more than 1½ times the width of the street, and that on wide streets no such building should exceed 120 ft. in height. The limit of buildings which are not fire-proof is 85 ft., and the resolution expresses the opinion that no buildings except those used for office purposes should be more than 85 ft. high, whether fire-proof or not.

THE CHICAGO SHIPYARDS have laid the keel for two steel vessels, and expect to begin two more shortly.

THE NEW RAILWAY STATION AT HAMBURG, Germany, is to cost 50,000,000 marks, or about $12,000,000, says the London *Railway News*. The new station at Cologne, says the same journal, is to be the largest and finest in Germany and will require nearly 25,000 tons of iron in its construction.

THE NORTH RIVER BRIDGE CO., Mr. GUSTAV LINDENTHAL, engineer, has had its revised plans approved by acting Secretary of War Grant. The new plans provide for a clear height of 150 ft., at center above mean tide.

THE MISSOURI RIVER IMPROVEMENT CONVENTION, lately in session in Detroit, Mich., demands from Congress an annual appropriation of $5,000,000 for the Missouri River and $7,000,000 annually for the Mississippi River, so long as the work may need it. It wants these appropriations to be separated from the river-and-harbor bills.

THE HOP INDUSTRY, as shown by Census Bulletin No. 143, shows an increase from 133,000 bales (of about 200 lbs. each) in 1880 to about 200,000 bales in 1889 and 1890. In the latter year, however, the product was worth 30 cts. per lb., and in the previous year only 10 cts. New York produces about half the total crop on 73% of the acreage. The remainder of the crop is nearly all raised on the Pacific coast. Ten counties only, five in New York, two each in Washington and California, and one in Oregon, produce 72% of the total crop.

AN ELECTRIC SHIFTING ENGINE is to be built by the Short Electric Railway Co. for use on the Atlantic & Chattahoochee Railway. The engine is to weigh 20 tons, and will be driven by one double reduction motor, calculated to furnish 100 HP. It is designed to pull 7 or 8 ordinary freight cars of 20 tons each at a speed of 5 or 6 miles per hour, and surmount grades of 5½%.

THE UNITED STATES PORTELECTRIC CO. has been incorporated, with $2,000,000 capital, for the rapid transmission of mail and express matter. The president of the company is Mr. THOMAS L. JAMES, formerly Postmaster-General of the United States. A line between New York and Brooklyn is talked of.

A LARGE STEEL PLANER, weighing 150 tons, was recently shipped from the Pond Machine Tool Works, in Plainfield, N. J. It was for a Pittsburg firm, and two others of similar dimensions are being built from the designs of Mr. JAMES E. GREENSMITH. The bed of this planer weighs 43 tons, the table 26 tons and the cross-rails, 22 tons. The Pond Co. has already made six gun-lathes for the Government.

THE DREXEL INSTITUTE, which was dedicated in Philadelphia last week, was endowed with $1,000,000 on that occasion by Mr. Drexel. The institute itself cost about half that sum. The carrying out of this most laudable benefaction in his lifetime conveys a lesson to other rich men who propose to leave the execution of their plans exposed to the interpretation of executors or to the efforts of contesting heirs.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Plymouth & Middleboro.—The contract for building this railway from Plymouth to Middleboro, Mass., has been awarded to McCarty Bros., Franklin, Mass., the work to be completed by July 1, 1892.

Pennsylvania.—The Alloway & Quinton R. R., from Alloway to Quinton, N. J., 4.2 miles, has been opened for traffic.—Contracts are now being let for double tracking the Mount Joy branch from Lillerville to Middletown, Pa.—Contracts will soon be let for building the Roxborough R. R., from a point on the Chestnut Hill branch to the Trenton cut-off, about 10 miles. There will be one 60-ft. bridge on the line.

Odessa & Middletown.—The grading on this 4¼-mile railway from Odessa to Middletown, Del., is nearly completed and tracklaying is making good progress. It is expected to have the line completed by Jan. 20, 1892.

Wabash.—About 400 teams and a large force of men are now at work on the extension from Montpelier, O., to Hammond, Ind.

Boston & Maine.—This company has laid second track as follows during the present year: South Newmarket to South Newmarket Junction, N. H., 1 mile; Dover, N. H., to South Berwick, Me., 5.96 miles; Cliftondale to West Lynn, Mass, 3.9 miles; Ipswich to Salisbury, Mass., 11.5 miles.

Projects and Surveys.

Columbus & Westerville.—At a meeting of the stockholders recently held the organization of this company was completed by the election of the following officers: President, M. H. Neil; Vice-President, F. A. Simons; Secretary, G. W. Meeker, and Treasurer, Adam Innis. Preparations are being made for beginning the work.

Washington & Chesapeake Beach.—At a recent meeting of the stockholders the following officers were elected: President, Henan D. Wallbridge; Vice-President, B. F. Karnes; Secretary and Manager, T. W. Tyrer; Treasurer, John G. Slater, and General Counsel, A. H. Garland. The company proposes to build a road from Washington, D. C., to Chesapeake Beach, 30 miles.

Syracuse & Oneida Lake.—This company, whose incorporation was noted in our issue of Oct. 17, proposes to build a railway from South Bay, on Oneida Lake, to Messina Springs, N. Y., 10 miles, where connection will be made with the proposed Syracuse, Eastwood Heights & De Witt Electric R. R. to Syracuse. Walter F. Randall, Syracuse, N. Y., Chief Engineer.

SOUTHERN.—Existing Roads.

West Virginia & Pittsburg.—It is stated that track laying has begun south of Sutton, W. Va., on the extension to the Gauley River. It is expected to complete the line as far as Elk River this season and then discontinue work until spring.

Roanoke & Southern.—Tracklaying has been completed on the extension from Winston, N. C., to Roanoke, Va., and the road will be put in operation about Jan. 13, 1891.

South Florida.—The work of tracklaying on the extension north from Pemberton, Fla., is progressing, and rail is on hand or en route to lay track as far north as Inverness, Fla., where connection will be made with the Silver Springs, Ocala & Gulf Ry. The further extension of the line to connect with the Savannah, Florida & Western Ry. is under consideration, and will probably be commenced within a short time.

Projects and Surveys.

Champion Lumber Co.,—This company will construct a 4½-mile, standard gage tram road for logging purposes. Steel rails weighing 35 lbs. per yard will be used. N. M. Brandon, Meridian, Miss., Chief Engineer.

East Virginia & Tidewater.—A bill has been introduced into the Virginia Legislature to charter this company to build a railway from some point in Hanover, Spottsylvania or Caroline counties, to some point on Chesapeake Bay in Gloucester, Matthews or Middlesex counties. Among the incorporators are: John Tyler, F. E. Montague, J. F. T. Anderson and others.

Virginia.—Bills have been introduced into the Virginia Legislature authorizing the Virginia Pyrites Mining Co. and the Allegheny Iron Co. to build railways.

Florida, Georgia & Carolina.—A bill is before the South Carolina Legislature chartering this company to build a railway from some point on the Savannah River near Mt. Carmel, S. C., via Abbeville and Greenville to the North Carolina line.

Walterboro & Otranto.—A bill is before the South Carolina Legislature chartering this company to build a railway from a point near Walterboro, S. C., via Summerville to Otranto, S. C. Among the incorporators are: H. St. J. Card, R. A. Pringle and W. G. Whaley.

South Carolina.—Bills have been introduced into the South Carolina Legislature chartering the Augusta, Aiken & Sumter R. R. Co., and the Eutawville & Summerville R. R. Co.

West Florida & Northern.—Chartered in Florida to construct a railway from a point on St. Andrew's Bay in Washington Co., Fla., north to a point on the Alabama line in Holmes Co., Fla.; then from a point on St Andrew's Bay, east to Wewahitchka in Calhoun Co., Fla., thence from Apalachicola in Franklin Co., Fla., to St Joseph, thence north to a point on the Alabama line, in the county of Jackson. The length of the road will be 190 miles; the capital stock $3,600,000. The incorporators are: J. G. Fuller, Roswell Shinn, John E Cailey of Chicago, E. S. Lawrence of South Spafford, N. Y., J. D. Pirrong of Wewahitchka, Fla., John Barr Glenn of Chipley, Fla., and J. D. Martin of St. Andrews, Fla.

NORTHWEST.—Existing Roads.

Canadian Pacific.—The Souris extension has been completed to the Moose Mt. Creek and will soon be opened for traffic.

St. Louis & Superior Terminal.—About 3 miles of the grading have been completed on this belt line at Duluth, Minn., and Superior, Wis.

SOUTHWEST.—Existing Roads.

Natchez, Red River & Texas.—It is rumored that this company will build an extension from Black River to Alexandria, La.

Velasco Terminal.—Tracklaying has begun on this railway from Velasco to Arcola, Tex., 60 miles.

Houston, Central Arkansas & Northern.—It is stated that tracklaying has been completed on this railway to within 10 miles of Alexandria, La., and will be completed to that place in a few days. The bridge across the Red River at Alexandria is well along toward completion, and unless unexpectedly delayed will be finished by Jan. 1, 1891.

Atchison, Topeka & Santa Fe.—This company will soon begin surveys for a line from Salem to Mt. Grove, Mo.

Pan American.—Grading has commenced on this line south from Victoria, Tex.

Mississippi River & Bonne Terre.—The extension of this railway to Doe Run, Mo., 16 miles, has been completed, and will at once be opened for traffic.

Projects and Surveys.

Springfield, Yellville & White River.—Incorporated in Arkansas to build a line of railway from a point on the Missouri line in Boone Co. south to a point on the Missouri River in Crittenden Co., a distance of 225 miles. Among the incorporators are: E. H. Webster, O. C. Hadley, W. R. Jones and others.

Missouri Southeastern.—Geo. H. Crumb, of Bloomfield, Mo., President, writes us as follows:

The surveys have been completed for this 61½-mile railway and the right of way is all secured. The company will do all construction work itself and it is expected to have the line ready for tracklaying by March 10, 1892, and opened for traffic a month later. The work will be light; maximum grade 0.6%, and maximum curve 4°. The route is through a farming and timber country, and the principal business of the road will be in timber and timber products and in farm produce. C. W. McCrea is Chief Engineer.

ROCKY MT. AND PACIFIC. Existing Roads.

Great Northern.—Work is well advanced on the spur to connect the Pacific extension with the Northern Pacific R. R. at Sand Point, Idaho. As soon as this is completed it is expected to begin tracklaying from this point both east and west on the Pacific Extension.

Rio Grande Southern.—Tracklaying has been completed on this Colorado railway. The road runs from Dallas to Durango, Colo., about 160 miles, of which 121 miles have been built this year.

Santa Fe, Phœnix & Prescott.—The surveys are well advanced on this line from Phœnix, Ariz., north to Prescott, Ariz., and from reports it seems probable that the line will be rapidly constructed. The work will be quite heavy; maximum grade 2%. There will be three tunnels, the longest of which will be 1,700 ft. Contracts, it is stated, will soon be let. N. R. Gibson, Phœnix, Ariz., chief engineer.

FOREIGN.

Hidalgo.—Surveys are stated to be in progress for an extension of this railway to Tuxpan, Mex. The route would, it is stated, pass through a rich country.

CITY TRANSIT.

Electric Railways.—***Brooklyn, N. Y.***—The Board of Aldermen has passed an ordinance authorizing the street railways to adopt the overhead wire system of electric traction. The companies are to use iron or steel poles not over 20 ft. high, placed on the curb line, and are also authorized to hang their wires from the elevated railway structures. The speed is limited to 10 miles an hour. Each company is to give a bond of $150,000 to indemnify het city against damages, but no provision is made for any payment to the city for the privilege granted.

Atlanta, Ga.—The Atlanta & Chattahooche Ry. Co. has adopted the Short electric system. The road will be 15 miles long, laid with 56-lb. steel rails, and will be used for freight and passenger traffic. The power house will be of granite, 60 × 100 ft., with 2 Reynolds-Corliss engines of 150 HP., 4 boilers of 150 HP. and 2 Short dynamos of 150 HP. There will be 4 closed and 6 open cars, built by the J. G. Brill Co., of Philadelphia, with 2 gearless motors of 10 HP. to each. Mr. C. J. Simmons is President of the company.

Velasco, Tex.—The Velasco & Surf Side Ry. Co. has awarded the contract for the construction of its electric road to Downey Bros., of Houston, Tex.

New Companies.—Hornellsville Electric Ry. Co., of Hornellsville, N. Y.; Benton McConnell, E. F. Wellets and John Adsit; $50,000. Ottumwa Electric Ry. Co., of Ottumwa, Ia.; J. B. Sax, Geo. P. Daum and Calvin Manning; $50,000. Fresno Electric Ry. Co., of Fresno, Cal.; B R. Woodworth, Lewis Leach and Morris Messenger; $1,000,000. Electric Railway Development Co., of San Francisco, Cal.; J. W. Dunlap, I. V. Hitchcock and W. M. Fitzmaurice; $500,000. Ottawa, Starved Rock & Western Electric Ry. Co., of Ottawa, Ill.; F. Walther and H. W. Huehl; $150,000.

HIGHWAYS.

New York.—The Supervisor of the town of Flushing, L. I., has asked the County Board of Supervisors for authority to bond the town for two-thirds of the cost of macadamizing the Jamaica and Flushing road.

California.—A project for a county road in San Diego Co., from Foster's Station, the terminus of the San Diego, Cuyamaca & Eastern R. R., to San Jacinto, is under consideration, and has been reported upon by W. W. Allen, County Surveyor, and T. M. Toop and John Ginty, Road Viewers. A report upon a railway over the same route has been made by Mr. Robt. B. Stanton, M. Am. Soc. C.E.

Pennsylvania.—A boulevard from Scranton to Elmhurst is to be built. It will be 6 miles long, have a roadway 40 ft. wide, and cost $20,000.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Boston, Mass.***—Sealed proposals will be received until Jan 5, 1892, for constructing L St. bridge. Plans and specifications can be seen at the office of the City Engineer, Wm. Jackson, 50 City Hall, Boston.

Ft. Myers, Fla.—Bids will be received until Jan. 4, 1892, for building a bridge over Orange Creek. F. J. Wilson.

West Superior, Wis.—It is stated that the Duluth, Red Wing & Southern Ry. will at once build a $10,000 bridge at this place.

Sioux City, Ia.—The city engineer has prepared plans for an iron bridge over Perry Creek, at Fourth St. It will cost about $4,000.

St. Paul, Minn.—The city engineer has been ordered to prepare plans for a bridge along the line of Grove St. to East Seventh and along the line of Burr St. to Woodward Ave.

St. Louis, Mo.—Bids will be received until Jan. 5 for removing bridge No. 3 at Forest Park and replacing it with a stone and iron structure. Board of Public Improvements.

Kansas City, Mo.—The officials of the Kansas City, Fort Scott & Memphis, the Atchison, Topeka & Santa Fe and the Chicago, Burlington & Quincy Railway Cos. are contemplating expending $25,000 for the construction of an iron viaduct on Brook St., from Twenty-third to Liberty St., a distance of 600 ft. The viaduct will cost about $35,000, and the city will be asked to donate $20,000 toward its construction.

King Co., Wash.—Bids will be received until Jan. 5 for constructing a 180-ft. iron bridge, with steel piers. F. A. Twitchell, County Auditor.

WATER-WORKS.

NEW ENGLAND.

Manchester, N. H.—It is reported that the water commissioners favor a high service system for Wilson Hill, which will include a pumping station drawing water from Lake Massabesic with a 2,000,000-gall. pumping plant, 20,000 ft. of 16-in. pipe and a reservoir. The estimated cost is about $136,000.

Williamstown, Vt.—It is reported that the Williamstown Granite Company will build a reservoir and supply water for domestic uses from a spring recently purchased.

West Medway, Mass.—It is reported that the proposed Medway Water Co., noted last week, intends to supply this place also, and that the supply will be from a reservoir.

MIDDLE.

Afton, N. Y.—The Afton Water Co. was incorporated Dec. 18 by George Brooks, J. Warren Lamb and others Cooperstown, N. Y., the former holding the majority of the stock, which is fixed at $21,000.

Ballston Spa, N. Y.—The people have appointed a new committee on an increase to the water supply, including Matthew Vassar and T. J. Tracy. The people also requested the village trustees to employ an engineer to investigate the best method of utilizing such water as is now available.

Dryden, N. Y.—The sum of $12,000 has been voted for works.

Medina, N. Y.—Proposals for the construction of works are wanted by the village trustees until Jan. 5.

Newburg, N. Y.—A special commission to have charge of the construction of the proposed improvements is under consideration. An election to vote $135,000 for the work is soon to be held.

New Rochelle, N. Y.—A 2,000,000-gall. Worthington pump has been contracted for.

Syracuse, N. Y.—W. R. Hill, Chief Engineer of the Syracuse Water Board, informs us that the commission appointed to appraise the property of the Syracuse Water Co. has placed its value at $850,000. This is the amount named by J. J. R. Croes in his report of Jan. 28, 1889, but is not stated whether it is intended to be the same or is a coincidence. The city has authority to buy the works.

Warsaw, N. Y.—It is reported that the village trustees have been talking of submitting to popular vote the feasibility of works to be owned by the city. The present supply is furnished by a company.

Stockton Township, N. J. (near Camden).—The people have voted to contract with a company for water from artesian wells.

Reading, Pa.—Bonds to the amount of $150,000 will probably be issued soon to pay for new mains.

Somerset, Pa.—The borough has voted $27,000 in bonds for works.

SOUTHERN.

Sumter, S. C.—Bids are wanted for a franchise to be granted by the city. W. A. Pringle, Jr., is City Clerk.

Albany, Ga.—The Council proposes to order an election to vote on the issuance of $50,000 for water works and sewerage systems. It seems that the works contracted for with the late Nelson Tift have not been built.

Birmingham, Ala.—The Birmingham Water-Works Co. has engaged consulting engineer J. T. Fanning, Minneapolis, to report on an additional supply.

Harriman, Tenn.—The Harriman Water Co. has been organized and filed articles of incorporation by J. D. Roberts and others. The temporary works of the East Tennessee Land Co., and, as noted last week, its franchise has been sold to the new company. It is expected that the construction of permanent works will be started soon.

NORTH CENTRAL.

Bowling Green, O.—The council has been requested to secure information regarding the construction of works, and to employ an engineer to report on a supply from wells.

Cincinnati, O.—Representatives of various commercial bodies have proposed a bill to be presented to the legislature, which provides for the appointment of four commissioners to build new works, with a daily capacity of 100,000,000 galls., at a cost of $6,000,000 or less. H. P. Boyden is interested. The proposed bill is published in full in the *Commercial Gazette*.

Madisonville, O.—The council has appointed a committee to report on the building of works.

Delphi, Ind.—The works were to be tested Dec. 22. G. C. Morgan, Chicago, was engineer.

Sault Ste. Marie, Mich.—The city has contracted for a 2,500,000-gall. Worthington pumping engine.

Farmer City, Ill.—An election will be held to vote on the issuance of $15,000 of bonds for water-works and sewerage.

Palo, Ill.—A test of the new works was to be made Dec. 19. G. C. Morgan, Chicago, was the engineer and contractor.

Winnetka, Ill.—Prospects for works are reported as favorable, Mead & Coe having offered to donate the necessary land.

Green Bay, Wis.—W. K. Harrington, Superintendent, informs us that about a mile of new mains has been ordered for next year.

NORTHWESTERN.

Granite Falls, Minn.—Bids for the construction of the village works noted last week were to be opened Dec. 26. C. L. Hardy is recorder.

Belt, Mont.—Works are being built by a company in which Barker Bros. are interested.

SOUTHWESTERN.

Eagle Pass, Tex.—Bids for building city works will be received until Jan. 19, regardless of the suit brought to test the legality of the incorporation of the city. Should the latter be declared illegal an election to reincorporate will be held at once.

Sherman, Tex.—The city works may be improved at a cost of $8,000. J. W. Levy is Mayor.

PACIFIC.

Santa Paula, Cal.—The Santa Paula Water Co. has been incorporated; capital stock, $150,000. W. L. Hardison is president; A. C. Hardison, secretary, and N. W. Blanchard, vice-president.

Vallejo, Cal.—Estimates of the cost of city works are being secured. Address Engineer Simonton.

FOREIGN.

Pachuca, Mex.—A company with a capital stock of $250,000 has been formed, with Richard Honey, G. M. Stewart, and others as directors.

ARTESIAN WELLS.

Brenham, Tex.—The water company will sink a 6 in. well.

Waco, Tex.—J. B. Tscharner, Manager of the Waco Water & Light Co., informs us that the new well is now down 1,300 ft., and that on its completion another will be started, making the fourth.

Medford, Ore.—An artesian well company has been incorporated to ink wells in the Rogue River Valley.

IRRIGATION.

Walla Walla, Wash.—Charles H. Leadbetter and George McCoy, of Portland, and Joseph Merchant, of Wallula, have filed a claim for 1,000 second-feet of water to be taken from the Walla Walla River, 9 miles above Wallula. A dam across the river and cañon, 35 ft. high, is proposed, as is an irrigating ditch. It is expected that 35,000 acres of land between Walla Walla and the Snake and Columbia rivers can be irrigated.

Elsinore, Cal.—The legality of the organization of the Elsinore Irrigation District has been established and it is expected that bonds, already voted, will be issued and works completed. Arrangements have been made, according to reports, for a supply of water from the Bear Valley reservoir.

Orange, Cal.—The *News* of this place states that the Santa Ana Valley Irrigation Co. proposes to cement 5,5H ft. of their canal.

Riverside, Cal.—The formation of a district to be known as the Riverside and to include land east of the Gage Canal is projected. C. O. Perrine, H. D. Noland and Surveyor S. R. Langworthy have been appointed as a committee to prepare for the formation of the district.

San Marcos, Cal.—The recent irrigation election was almost unanimously for irrigation. R. B. Borden has been elected treasurer and S. R. Golden is one of the directors of the district. It is thought likely that Moffett, Hodgkins & Clarke, Syracuse, N. Y., may secure a contract to furnish water to the district from the San Luis Rey system, as it has already done from the adjoining district of Escondido.

Yreka, Cal.—The formation of the Montague Irrigation District has been voted. J. M. Walbridge and H. L. Davis are directors.

New Companies.—North Side Lateral Irrigation Co., Fort Morgan, Colo., $5,000; W. A. Hill, G. A. Gordon and others. Pecos Irrigated Farms Co., Eddy, N. M., $250,000; farming and developing irrigated lands, constructing and operating irrigating ditches, etc.

SEWERAGE AND MUNICIPAL.

Sewers.—*Massachusetts*—Revere. The committee recently appointed to consider the question of sewage disposal reports as follows: "That the town drain Crescent beach and Beachmont by gravitation into the ocean; that the Oak Island and Point of Pines district be drained into Pines River, and that the old part of the town be drained into Sales Creek." The estimated expense is $70,000. The report was accepted and bids will be asked.

Connecticut.—Meriden. An appropriation of $85,000 for sewerage has been voted.

New York.—Niagara Falls. Engineer Johnson has prepared a plan for a general sewerage system. The commissioners are busy formulating some proposition to submit to a vote of the people.

Maryland.—Hagerstown. In an open letter Mayor Halm argues in favor of a system of sewerage and the proposition of the Lewis-Mercer Construction Co., of New York.

Ohio.—Cincinnati. The contract for a sewer in Berneh Woods has been awarded to J. F. Deters, at $11,813. The contracts for several sewers in Division 17 were awarded to M. Peter & Son, at $72,220. There were 8 other bids ranging from $81,449 to $103,666.

Indiana.—Bloomingdale. The sewer committee has decided that the drainage of Ward 9 is a necessity that must not be deferred longer than next spring. The committee has also decided upon a 6-ft. brick sewer and two tributary 3-ft. brick sewers for the drainage of a portion of the city.

Michigan.—Detroit. City Engineer Ludden reports that sewers aggregating 17,980 ft. and estimated to cost $91,733 should be constructed as soon as possible.

Colorado.—Denver. The council is to be asked for an additional $20,000 to complete the tributary sewers.

California.—Oakland. The Grand Jury recommends that several wooden sewers be reconstructed with iron-stone pipe; and also recommends other sewer improvements.——San Mateo. A franchise has been granted to W. T. Reid to construct and maintain a main sewer with branches and connecting sewers in and along certain public highways and streets in San Mateo Co.

S reets.—*Pennsylvania.*—Reading. It has been decided to pave with sheet asphalt one street and others are under consideration.

Illinois.—Peoria. Estimates have been submitted for paving on 7 streets to cost $188,460.

Georgia.—Savannah. The city budget for next year contains $40,000 for street paving, an increase of $5,000 over the past year.

Tennessee.—Chattanooga. City Engineer Hook reports that the contemplated paving around the custom house will cost $10,900 in asphalt, and $9,000 in brick.

Bonds.—Ogden, Utah; $15,000 for sewers. Ridgewood, N. J.; $60,000 for street improvements, to be voted on Dec. 30.

ELECTRICAL.

Electric Light.—*Quakertown, Pa.*—It is intended to expend $15,000 for electric lights.

Mobile, Ala.—The city desires bids for a plant with a capacity of 200 arc lights of 2,000-c. p.

Dayton, Tenn.—The City Council has contracted with Burkhalter & Gibson to put in a plant. The city agrees to take 12 or more lights at $120 per month for 10 years.

Nashville, Ill.—A plant will soon be established.

Pekin, Ill.—A franchise to last 20 years has been granted to a company headed by George Herget and Henry Smith.

Dubuque, Ia.—The Mayor finds that the city could save $1,000 per month by operating its own plant, and the City Council has the matter under consideration.

Milwaukee, Wis.—The Badger Illuminating Co. has been awarded the city electric light contract for another 4 years at $110 a year per light.

Santa Barbara, Cal.—A franchise has been granted to the National Electric Development Co. for electric lights and power.

New Companies.—State Electric, Heat & Power Co., Jersey City, N. J.; to operate at Bayonne and Jersey City, N. J., and New York City; H. V. Cole, E. S. Frazer and A. F. Crawford; $100,000.——Adirondack & St. Lawrence Telegraph & Telephone Co., New York; W. S. Webb, H. L. Sprague and J. H. Pratt; $75,000.

CONTRACTING.

Sewer.—*Terre Haute, Ind.*—A contract for a 12-in. pipe sewer, with 1 manhole and 2 catch basins and 10-in. pipe leading to them, has been awarded to G. W. Glick at 85 cts. per ft., including manhole and catch basins. Other bids ranged from 60 to 85 cts. per ft. for the sewer, with manholes at $18 to $35 and catch basins $56 to $65 extra.

Dredging.—*Boston, Mass.*—Lt.-Col. S. M. Mansfield, U. S. Engineer Office, has opened the following bids for dredging in Boston Harbor: Metropolitan Dredging Co., Lynn, Mass.; 30 cts. per cu. yd., scow measure; $10 per cu. yd. for removal of bowlders over 6 tons. Charles H. Souther, Boston; 17⅜ cts.; no bid. Augustus R. Wright, Portland, Me.; 17 cts.; $4.

Setting Lamps.—*Brooklyn, N. Y.*—The contract for setting gas lamps on Evergreen and Hamburg Aves. has been awarded to the Williamsburgh Gas Light Co. at $25 per lamp post.

Paving Blocks.—*Cambridge, Mass.*—The Committee on Roads and Bridges has awarded the contract for 200,000 granite paving blocks to S. & R. J. Lombard at $37.85 per M. Other bids were from $38.50 to $43.90.

PROPOSALS OPEN.

Brick Paving.—*Beatrice, Neb.*—About 35,000 sq. yds of brick paving, 2 courses of brick on sand. The contract will embrace about 6 miles of streets. F. S. Davis, City Engineer. Jan. 2.

Cement.—*San Francisco, Cal.*—For furnishing 1,000 bbls. before March 31, according to specifications; also sundry work and materials. New City Hall Commissioners. Jan. 12.

Plumbing.—Labor and material for plumbing and gas-piping of U. S. building at Port Townsend, Wash. W. J. Edbrooke, Supervising Architect, Treasury Department, Washington, D. C. Jan. 8.

Dredging.—Bar at the entrance of Honolulu Harbor, Hawaii, to a depth of not less than 30 ft., length about 1,100 ft., width not less than 200 ft. Hydraulic dredger furnished free by government. Specifications at the office of the Consul-General, 302 California St., San Francisco. Jan. 14.

Drainage Pump.—*New Orleans, La.*—For the construction of a drainage pump. Otto Thoman, Comptroller. Feb. 18.

Valves and Castings.—Gate valves and steel castings for the Washington Navy Yard. T. J. Lasier, Bureau of Provisions and Clothing, Navy Department, Washington, D. C. Jan. 5.

Public Building.—Cut stone work and brick work of the superstructure of the United States building at Newark, N. J. W. J. Edbrooke, Supervising Architect, Treasury Department, Washington, D. C. Jan. 9.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Richmond Locomotive & Machine Works, of Richmond, Va., have an order for 11 ten-wheel engines for the Chesapeake & Ohio. The Baldwin Locomotive Works, of Philadelphia, Pa., have orders on hand for 20 engines for the Lehigh Valley, and 6 for South America.

Cars.—The Jackson & Woodin Co., of Berwick, Pa., has an order for 1,000 freight cars for the Lehigh Valley. The St. Charles Car Co., of St. Charles, Mo., is building 30 passenger cars for the Chicago, Burlington & Quincy, and 500 box cars for a Minneapolis firm. The Litchfield Car Works, of Litchfield, Ill., are building 500 freight cars for lease. The J. G. Brill Co., of Philadelphia, Pa., will build 15 electric cars for the Second Ave. Passenger Ry. Co., of Pittsburg, Pa., and 10 electric cars for the Atlanta & Chattahoochee Electric Ry. Co. The Central Equipment Co., of Terre Haute, Ind., has been organized to build cars; $50,000. President, Robert S. Cox.

The Automatic Temperature Regulator for steam treated cars made by the Consolidated Car Co. will be used on a good portion of the Delaware & Hudson passenger equipment this winter, and on a considerable number of New York Central & Hudson River cars. The Consolidated Co. is equipping 106 new coaches of the latter road with an improved system of direct steam heating.

The Eppinger & Russell Creosoting Works, lately burned in Long Island City, are being rapidly rebuilt and will be in working order in about 30 days. The new plant will be much improved and will include 4 cylinders 6 ft. in diameter and 100 ft. long, with a daily capacity of 90,000 ft. B. M., making the works among the largest and most complete known. A singular feature of the fire was that no oil was lost, though two of the largest tanks of dead oil of coal tar were full and had open tops. The wooden jacketing to the tanks was burned, but the water on the top of the oil remained there, due to the greater specific gravity of the oil, and protected it from fire. All connections with these tanks are made from the bottom and from 1 to 2 ins. of water always stand on top of the oil. The present tank capacity is 150,000 galls.

New Companies.—Ray Valve Mfg. Co., of Elizabeth, N. J.; C. M. Lyman, W. T. Birdsall and Horace M. Williams; $100,000.—Detroit Car Window Ventilator Co., of Detroit, Mich., to manufacture the Reynolds Ventilator; H. H. Reynolds, W. H. Woodbury and C. M. Hammond; $10,000.—Alabama Bridge Co., of Anniston, Ala.; President, T. R. Houser; Engineer, W. E. Robertson.

The Berlin Iron Bridge Co. has contracted with the Detroit Dry Dock Co. to build a new fireproof, modern machine shop, for the Dry Dock Engine Works. The new shop will be 201 ft. by 66 ft., with the main part 200 ft. long, 37 ft. wide and 50 ft. high in the clear. Two 20 ton electric cranes will cover the whole length, with 38 ft. clear beneath the cranes. Every necessary modern appliance will be added, including the latest machinery, electric light, etc.

Metal Market Prices.—*Rails.*—New York: $30 to $30.50; old rails, $21 to $21.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $23 to $23.25 for iron and $17 to $18 for steel. Chicago: $31; old rails, $20.50 to $21 for iron and $14 to $15 for steel.

Track Materials.—New York; steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron and steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 to 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14.50 to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

Lead.—New York: 4.25 to 4.35 cts. Chicago: 4.05 cts. St. Louis: 3.9 to 4 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.5 to 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.1 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 1.95 to 2.1 cts. for tank, 2.15 to 2.2 cts. for shell, 2.35 to 2.4 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.1 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.2 cts. for tank, 2.6 to 3.5 cts. for shell, 2.6 cts. for flange.

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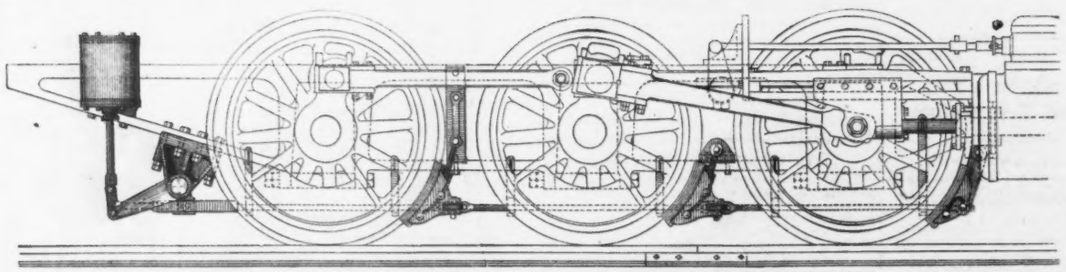

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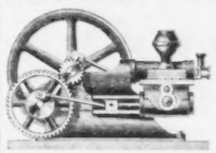

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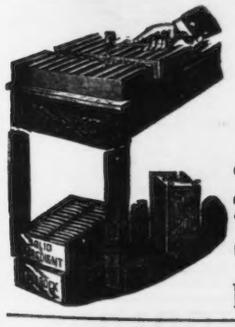

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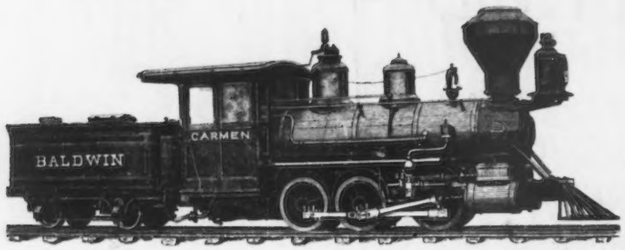

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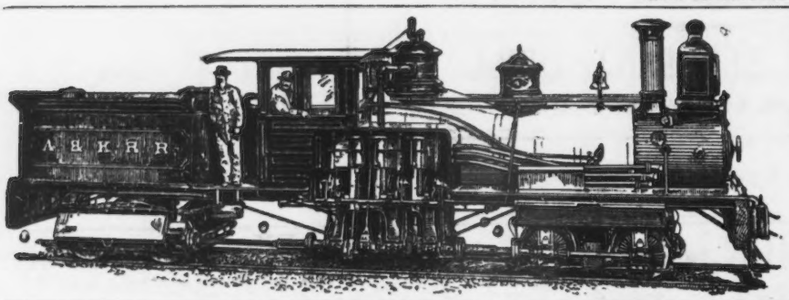

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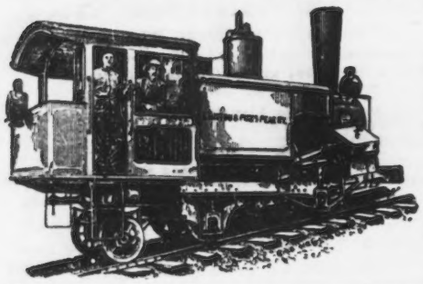

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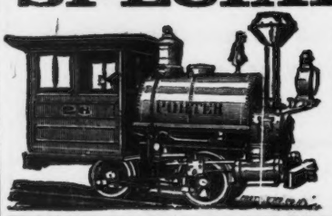

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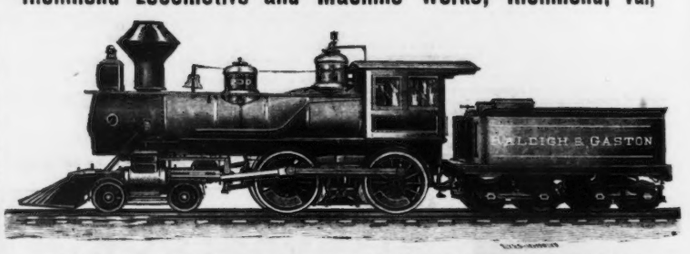

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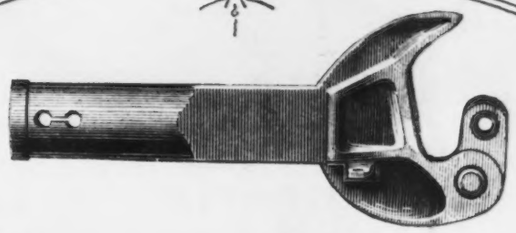

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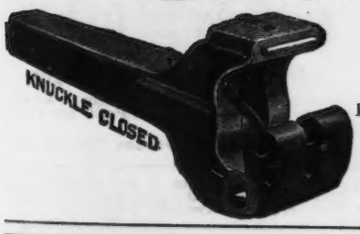

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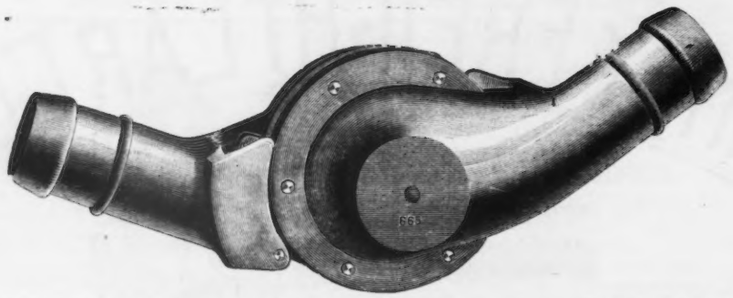

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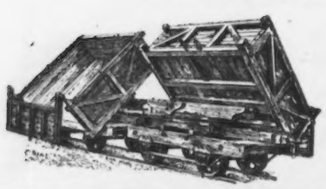

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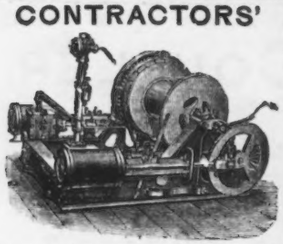

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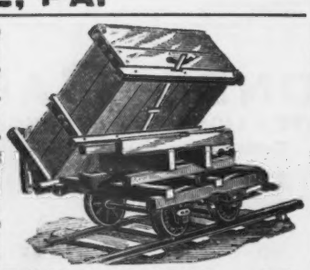

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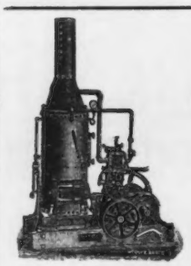

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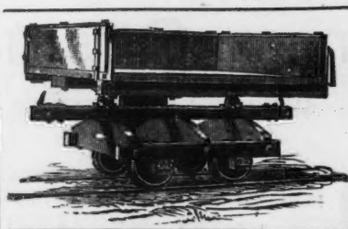

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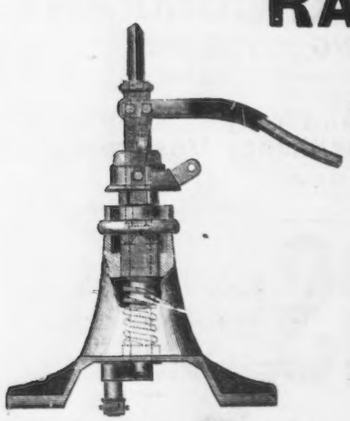

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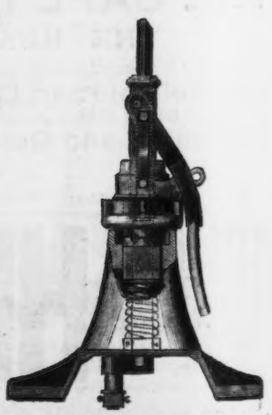

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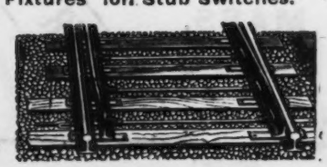

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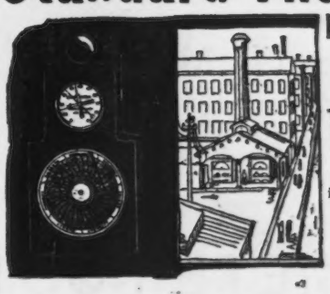

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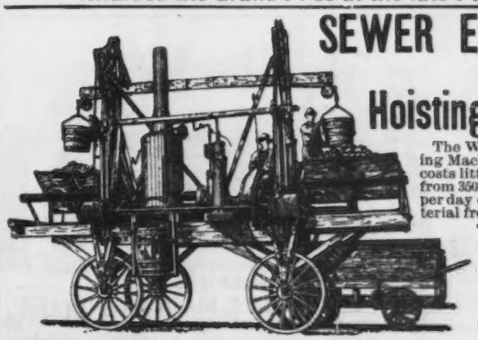

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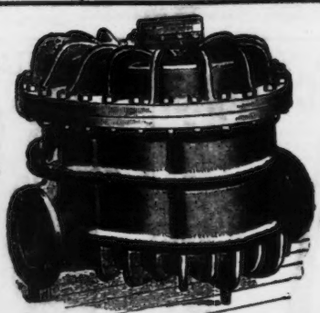

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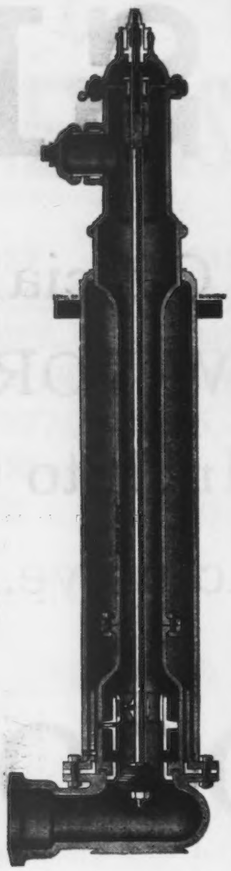

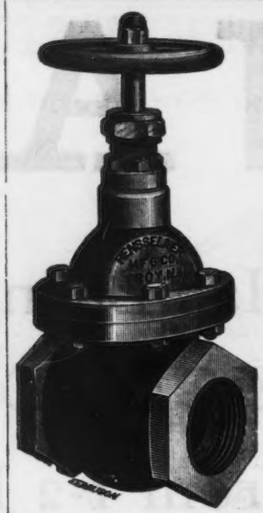

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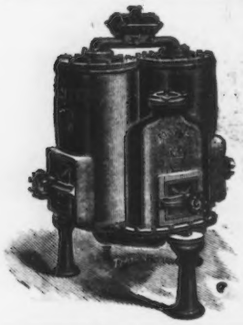

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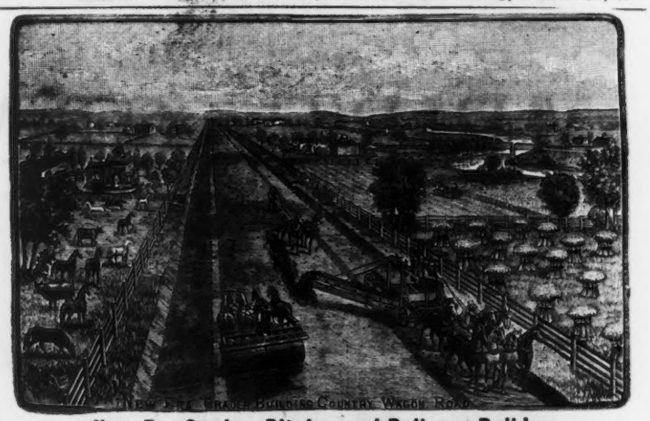

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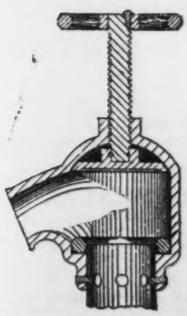

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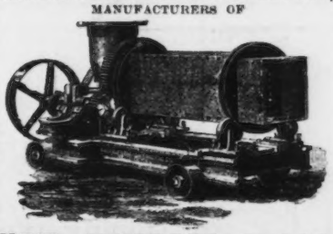

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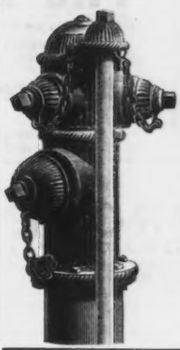

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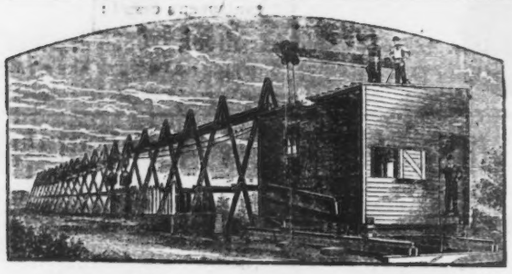

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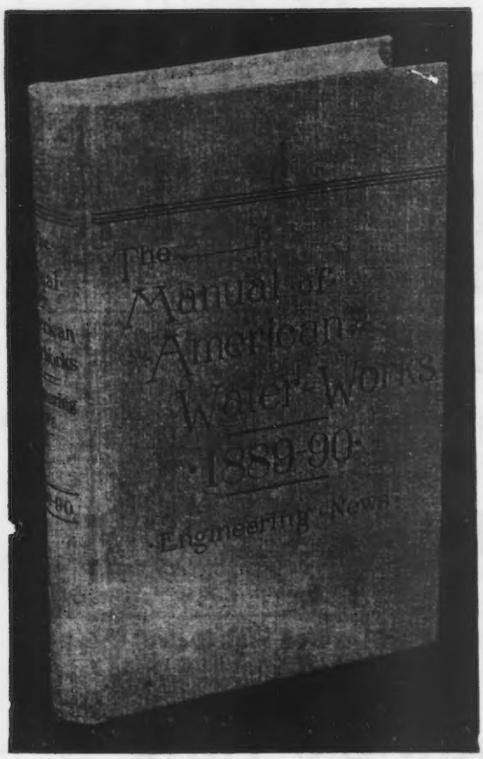

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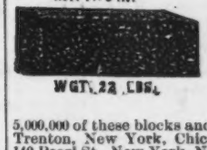

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METROPOLITAN SEWERAGE COMMISSIONERS—NOTICE TO CONTRACTORS.

Sealed bids for building Section 22 of the Metropolitan Sewerage System in Medford, in accordance with the form of contract and specifications to be furnished by the Board of Metropolitan Sewerage Commissioners, will be received by said board at its office, 93 Lincoln street, Boston, Mass., until 12 o'clock M. of WEDNESDAY, Dec. 23, 1891.

No bid will be received unless accompanied by a certified check for the sum of $1,000.

All bids must be made upon the blank forms furnished by the board.

Some other particulars are approximately as follows:

Section	Length, feet.	Average depth, feet.	External diameter, feet	Cu. yds. brick and other masonry.
22	6,075	21.5	5	2,200

Plans can be seen and specifications and forms of contract can be obtained at the above office.

Each bidder is required to make a statement indicating what sewer and similar work he has done, and to give references that will enable the board to judge of his business standing.

The board reserves the right to reject any and all bids.

HOSEA KINGMAN, TILLY HAYNES, ROBERT T. DAVIS, } Board of Metropolitan Sewerage Commissioners of Massachusetts.

HOWARD A. CARSON, Chief Engineer.

49-3t

Notice to Architects.

OFFICE OF THE BOARD OF PUBLIC WORKS, CITY OF DULUTH, Minnesota, November, 12, 1891.

Competitive plans for a drawbridge across the Duluth ship canal will be received by the board of public works in and for the corporation of the city of Duluth, until 2 P.M , on the 28th day of December, 1891, said plans to be drawn according to notes and specifications for the size and strength now on file in the office of said board, which will be furnished upon application. A cash prize of one thousand (1,000) dollars will be paid for the best plans furnished. Said plans must be accompanied with detail specifications and approximate cost of said bridge. The successful bidder in all probability will, if so desired, be engaged by the city of Duluth when the bridge is built to superintend the building of the same.

[Seal.] HENRY TRUELSEN, President.

Official:
T. W. ABELL,
Clerk, Board of Public Works. 47-3t.

WORTH KNOWING.

Some facts in connection with the "Royal Blue Line" of Interest to Travelers.

Among the finest cars ever placed in railroad service in this country are the Royal Blue Line cars now in use on the New York, Philadelphia, Baltimore and Washington line, running over the Baltimore & Ohio, Philadelphia & Reading, and Jersey Central Railways.

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These are improvements which are appreciated even by the lay traveler in the general way of increased comfort in riding, the vestibule attachment doing away with all lateral motion of the train and the heavy springs making the movement an easy, gilding one. The interiors of the coaches are, moreover, everything they should be to please the eye, being finished in mahogany, with plush trimmings and window curtains and other decorations harmonizing. Each coach has also a toilet room supplied with every convenience.

The speed at which these trains are run is in keeping with their high grade of construction, the journey between New York and Washington on two of them being made in five hours.

The remarkable part of the service is that only the regular fare is charged so that one has all the conveniences and comfort of traveling in a style that ordinarily costs something additional. It is a startling illustration of the advancement in railroading in the last few years and combines the highest essentials of progressive railroad management—the best that can be offered at the lowest possible rate.

That the enterprise of the several railroad companies concerned is appreciated by the traveling public is evidenced by the immense and constantly increasing patronage this service already enjoys. 49-3t

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Proposals for Paving Streets.

SEALED PROPOSALS will be received at the office of the city auditor of the city of Dayton, Ohio, until 12 o'clock, noon,

MONDAY, January 4, 1892.

For improving First street, from the west line of St. Clair street to the east line of Wilkinson street, estimate 11,000 square yards of paving.

Second street, from the west line of St. Clair street to the east line of Ludlow street, estimate 6,800 square yards of paving.

Third street, from the east line of Sears street to the river bridge, estimate 40,000 square yards of paving.

Fourth street, from the east line of Jefferson street to the east line of Ludlow street, estimate 4,500 square yards of paving.

Fifth street, from the railroad to the east line of Ludlow street, estimate 12,000 square yards of paving.

Main street, from the south line of Fifth street to the river bridge, estimate 25,000 square yards of paving.

Jefferson street, from the south line of Fifth street to the north line of First street, estimate 14,500 square yards of paving, by constructing necessary foundations and making necessary excavation for same, furnishing and paving the roadway with granite block, Medina block, Hayden block, Hallwood block, asphalt block, asphalt, red brick or fire brick, furnishing and setting new curbs, constructing the necessary culverts, drains, catch-basins, and retaining walls, in accordance with the plans and specifications on file in the office of the city civil engineer.

A deposit of five thousand ($5,000) dollars to be left in the hands of the city auditor, will be required of each bidder as a guarantee that if any bid is accepted a contract will be entered into and performance thereof properly secured.

All bids must be made upon the printed forms to be obtained at the office of the board of city commissioners, and enclosed in a sealed envelope directed to the board of city commissioners, Dayton, Ohio, and indorsed upon the outside of the envelope, "Proposals for paving —— street in the city of Dayton."

Each bid shall contain the full name of every person interested in the same. The board reserves the right to reject any or all bids or waive defects in bids in the interest of the city.

By direction of the board of city commissioners. W. E. HOOVEN, President.
C. A. HERBIG, City Auditor. 51-1t

MILLIONS OF DOLLARS worth of new contract work is being advertised weekly in ENGINEERING NEWS, Tribune Building, New York

Drainage Pump.

COMPTROLLER'S OFFICE, CITY OF NEW ORLEANS, NEW ORLEANS, Nov. 20, 1891.

Sealed proposals will be received at this office until the hour of 12 M., Thursday, Feb. 18, 1892, for the construction of a new drainage pump, in accordance with plans and specifications on file in the office of the City Engineer. Copies of plans and specifications will be forwarded by mail on request. A deposit of $200 will be required to accompany each bid. The city reserves the right to reject any and all bids. All in conformity with Ordinance No. 5,753, C. S., adopted Nov. 10, 1891.

OTTO THOMAN, Comptroller. 48-13t

Proposals for Water-Works.

Bids will be received by the City Clerk of the City of Snohomish, Wash., up to 6 o'clock P. M., Jan. 9, 1892, for furnishing all material and performing all work for constructing a complete water-works system for the City of Snohomish, Wash., according to plans and specifications now on file with the City Clerk of said city.

The system will consist of about 1 4-5 miles of 12 in. mains, ¼ mile of 10-in. mains, ¼ mile of 8-in. mains, 2⅝ miles of 6-in. mains, and ½ mile of 4-in. mains, on which will be placed 50 fire hydrants, with 6-in. connections to the mains.

Pipe to be of wrought iron.

There will be two pumps and two boilers; pumping capacity 1,000,000 galls. in 24 hours; a reservoir of about 500,000 galls. capacity.

Bidders will bid on the works complete, including the furnishing of all material and labor of whatever kind.

Each bid must be accompanied by a certified check or its equivalent for the sum of $1,000, which will be retained by the city in case the bidder fails to enter into the contract if it be awarded him.

Checks will be returned as soon as contract is signed.

Payments will be made monthly to the amount of 90% of the engineer's estimates.

A bond of $10,000 will be required of the successful bidder, besides the retention of 10% of the monthly estimates, until the works are completed and accepted by the city; work to begin at once and be completed by July 1, 1892.

The right is reserved to reject any and all bids.

Dated Dec. 9, 1891.

T. E. MARKS, City Clerk.
M. STIXRUD, Engineer in Charge.
501 Eurke Block, Seattle, Wash. 51-1t

WANTED—A responsible Civil Engineer about to make a trip through Mexico, California and the West will execute any commissions intrusted to him, or act as representative of manufacturers on very reasonable terms. MEXICO, care of Engineering News. 50-3t

PROPOSALS FOR

Sewage Pumping Engines.

OFFICE OF THE DEPARTMENT OF PUBLIC WORKS, CHICAGO, Dec. 2, 1891.

Sealed proposals will be received by the city of Chicago until 11 A. M. Tuesday, Dec. 29, 1891, for the construction, delivery and erection, upon and within the foundations provided by the city of Chicago, of two "Sewage Pumping Engines" and three boilers, together with the necessary feed pumps, pipes, &c., and complete in all details and particulars for constant daily use in connection with the web well and discharge conduit provided by the city of Chicago.

One engine to have a capacity to raise 12,000 000 U. S. gallons 15 ft. high every 24 hours.

One engine to have a capacity to raise 24,000,000 U. S. gallons every 24 hours.

According to plans and specifications on file in the office of the department of public works of said city.

Proposals must be made out upon blanks furnished by said office, and be addressed to said department, indorsed "Proposals for Sewage Pumping Engines," and be accompanied with $1,000 in money, or a certified check for the same amount on some responsible bank doing business in the city of Chicago, and made payable to the order of the commissioner of public works.

The commissioner of public works reserves the right to reject any or all bids.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names as well as the name of the firm, with their address.

J. FRANK ALDRICH,
50-1t Commissioner of Public Works.

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Seventh St. Line, for W. & G. R. R. Co., Washington, D. C.
Eleventh and Thirteenth Sts Line, for Tacoma Ry. & Motor Co., Tacoma, state of Washington.
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Brand, James, 81 Fulton St., N. Y.
Buckeye Portland Cement Co., Bellefontaine, O.
Cumberland Hydraulic Cement Mfg. Co., 67 William St., N. Y.
Dickinson Brothers & King, N. Y.
Fisher, E. W., 18 Broadway, N. Y.
Fleming, Howard, 23 Liberty St., N. Y.
French & Co., Saml. H., Philadelphia, Pa.
Howard Hydraulic Cement Co., Chattanooga, Tenn.
Johnson & Wilson, 45 Broadway, N. Y.
Lawrence Cement Co., 67 William St., N. Y.
Leslie & Trinkle, 210 South Third St. Philadelphia, Pa.
Meachem & Wright, 98 Market St., Chicago, Ill.
Norton, F. O., 92 Broadway, N. Y.
New York & Rosendale Co., 229 Broadway, N. Y.
Sinclair & Babson, 18 Exchange Place, N. Y.
Tomkins, Calvin, 150 Broadway, N. Y.
Thiele, E., 28 William St., N. Y.
Union Akron Cement Co., Buffalo, N. Y.
Western Cement Association, 247 W. Main St., Louisville, Ky.

Chimney Tops.
Ohio Valley Fire Clay Co., Toronto, O.

Coal Buckets and Chutes.
Focht, Geo., 61 Adams St., Hoboken, N. J.
Steubner, G. L. & Co., Long Island City, N. Y.

Cocks and Stops.
Galvin Brass & Iron Works, Detroit, Mich.

Colleges (Engineering).
Lafayette College, Easton, Pa.

Concrete Mixer.
Carlin's Sons, Thos., Allegheny, Pa.
Cockburn Barrow & Machine Co., 234 Eleventh St., Jersey City, N. J.

Concrete and McAdam Stone.
Carpenter Bros, Port Chester, N. Y.
Tomkins, Calvin, 150 Broadway, N. Y.

Condensation Process.
Hill, John W., 21 Glenn Building, Cincinnati O.

Construction Supplies.
French, Samuel H., & Co., Philadelphia, Pa.
Ryan-McDonald Mfg. Co., Baltimore, N. Y.
Tomkins, Calvin, 15 Broadway, N. Y.

Contractors (General).
Bassett Bros., 298 Main St., Buffalo, N. Y.
Boughen Engineering Co., Cincinnati, O.
Brown, Jas. M., & Co., 115 Broadway, N. Y.
Elliot & Phin, Brantford, Ont.
Frescoln, S. W., World Bldg., N. Y. City.
Harlow, J. H., & Co., Pittsburg, Pa.
Moffett, Hodgkins & Clark, Syracuse, N. Y.
Ricker, Lee & Co., Galveston, Tex.
Sparks & Evans, 436 Walnut St., Philadelphia, Pa.
Staats, R. P. & J. H., New York.
Woltmann, Keith & Co., 11 Wall St., City. C. A.: "Narcotic, N. Y."

Contractors' Supplies.
American Mfg. Co., St. Paul, Minn
Carlin's Sons, Thos., Allegheny, Pa.
Claffy, John, 48 Dey St., N. Y.
Contractors' Plant Co., Buffalo, N. Y.
French & Co., Samuel H., Philadelphia, Pa.
Ingersoll Sargeant Rock Drill Co., 10 Park Place, N. Y.
Iredell, F. W., 10 Park Place, N. Y.
McEwen, A. C., 79 Morgan St., Jersey City, N. J.
Middleton, W. S., 52 John St., N. Y.
Pierce & Thomas, 42 Cortlandt St., N. Y.
Ryan-McDonald Mfg. Co., Waterloo, N. Y.
Toledo F'dry & Mach. Co., Toledo, O.
M. Beatty & Sons, Welland, Ont.

Conveying Machines.
Brown Hoisting & Conveying Machine Co., Cleveland, O.
Industrial Works, Bay City, Mich.

Cornish Rolls.
Farrel Foundry & Machine Co., Ansonia, Conn. C. A.: "Farrel."

Coupler (for Steam Heating).
Consolidated Car Heating Co., Albany, N. Y.
Safety Car Heating and Lighting Co., 160 Broadway, N. Y.

Cranes.
Boston Bridge Works, Boston, Mass.
Brown Hoisting & Conveying Machine Co., Cleveland, O.
Farrel Foundry & Machine Co., Ansonia, Conn. C. A.: "Farrel."
Industrial Works, Bay City, Mich.
Manix Machine Co., Philadelphia.
Southwark Foundry Machine Co., Philadelphia, Pa.
Wood, R. D., & Co., 400 Chestnut St., Philadelphia, Pa. C. A.: "Tuckahoe, Philadelphia."
Edwin Harrington, Son & Co., Phila., Pa.

Cranes (Electric).
Boston Bridge Works, Boston, Mass.
Thomson Houston Motor Co., Boston. Mass.

Creosoting.
Carolina Oil & Creosote Co., Wilmington, N. C.
Eppinger & Russell, 160 Water St., New York.
Lehigh Valley Creosoting Works, Washington St., Jersey City, N. J.
Old Dominion Creosoting Works, 57 Main St., Norfolk, Va.
Vanderbilt & Hopkins, 120 Liberty St., New York.

Crushers.
Carlin's Sons, Thos., Allegheny, Pa.
Farrel Foundry & Machine Co., Ansonia, Conn.
Forsaith & Co., S. C., Manchester, N. H.
Iredell, F. W., 10 Park Place, N. Y.
Pierce & Thomas, 42 Cortlandt St., New York.

Culvert Pipe.
Blackmer & Post, St. Louis, Mo.
Ohio Valley Fire Clay Co., Toronto, O.

Culvert Pipe (Iron).
Addyston Pipe & Steel Co., Addyston, O.
Wood, R. D., & Co., 400 Chestnut St., Philadelphia, Pa. C. A.: "Tuckahoe, Philadelphia."

Cupola.
Byram & Co., Detroit, Mich.

Damp Course.
Sicilian Asphalt Paving Co., New York.

Derricks.
American Mfg. Co., St. Paul, Minn.
Beatty, M., & Sons, Welland, Ont.
Brown Hoisting & Conveying Machine Co., Cleveland, O.
McEwen, A. C., 79 Morgan St., Jersey City, N. J.
Middleton, W. S., 52 John St., New York.
Oil Well & Supply Co., Limited, 82 Fulton St., New York.
Ryan-McDonald Mfg. Co., Waterloo, N. Y.
Vulcan Iron Works, Chicago, Ill.

Ditching Machines.
Bucyrus Steam Shovel & Dredge Co., Bucyrus, O.
Marion Steam Shovel Co., Marion, O.
Osgood Dredge Co., Albany, N. Y.
San Francisco Bridge Co., San Francisco, Cal., and Seattle, Wash.

Diver.
Thacher & Breymann, 306 Water St., Toledo, O.

Diving Apparatus.
Morse, A. J. & Son, 140 Congress St., Boston, Mass.
Schraeder, A. & Son, 32 Rose St., N. Y.

Drain Tile.
Ohio Valley Fire Clay Co., Toronto, O.

Draw-Gear, for cars.
Union Switch Co., Pittsburg, Pa.

Dredging and Dredging Machinery.
Anderson & Barr, Jersey City, N. J.
Beatty, M., & Sons, Welland, Ont.
Bucyrus Foundry & Mfg. Co., Bucyrus, O.
Industrial Works, Bay City, Mich.
Marion Steam Shovel Co., Marion, O.
Osgood Dredge Co., Albany, N. Y.
Poole, Robt. & Son Co., Baltimore, Md. C. A.: "Poole, Baltimore."
Ross & Sanford, Jersey City, N. J.
San Francisco Bridge Co., San Francisco, Cal., and Seattle, Wash.
Toledo Foundry & Machine Co., Toledo, O.
Atlantic Dredging Co., 34 Pine St., New York.
Vulcan Iron Works, Chicago, Ill.

Drilling Tools.
Ingersoll-Sergeant Rock Drill Co., 10 Park Place, N. Y.
Rand Drill Co., 23 Park Place, N. Y.
Thomson-Houston Electric Co., 620 Atlantic St., Boston, Mass.

Drilling, Tapping, Reaming and Boring Machines (Portable).
Stow Flexible Shaft Co., Phil delphia, Pa
Stow Mfg. Co., Binghamton, N. Y.

Dumping Buckets (Automatic).
Brown Hoisting & Conveying Machine Co., Cleveland, O.

Dynamo Electric Machines.
Edison General Electric Co., N. Y.
Thomson Houston Electric Co., 620 Atlantic St., Boston. Mass.

Electric Blasting Apparatus.
Rendrock Powder Co., 23 Park Place, N. Y.

Electric Indicating and Recording Instruments.
Standard Thermometer Co., Peabody, Mass.

Electric Lighting and Motors.
Edison General Electric Co., N. Y.
Moffett, Hodgkins & Clarke, Syracuse, N. Y. Works at Peoria, Ill.
Thomson-Houston Electric Co., 620 Atlantic St., Boston, Mass.

Electric Lamps.
Edison General Electric Co., N. Y.
Thomson-Houston Electric Co., 620 Atlantic St., Boston, Mass.

Electric Motors.
Thomson-Houston Motor Co., Boston, Mass.

Electric Railways.
Edison General Electric Co., N. Y.
Thomson-Houston Motor Co., 620 Atlantic St., Boston, Mass.

Electrical Engineers.
Leonard & Co., H. Ward, Electrical Exchange Building, New York.
Jackson, D. C., Madison, Wis.
Paine & Sons, Charles, 71 Broadway, N. Y.
Smith, Jesse M., 36 Moffat Block, Detroit, Mich.
Moffett, Hodgkins & Clarke, Syracuse, N. Y.

Electrical Interlocking and Signaling Appliances (for railroads).
Hall Signal Co., 50 Broadway, N. Y. City.
Union Switch & Signal Co., Swissvale, Pa.

Elevator (Electric).
Otis Bros. & Co., 38 Park Row, N. Y.
Thomson-Houston Motor Co., Boston, Mass

Emery Wheel Grinding Tools.
Stow Flexible Shaft Co., Philadelphia, Pa.

Employment Bureau.
ENGINEERING NEWS, Tribune Bldg., N. Y. City.
Engineering Employment Bureau, 8 Granger Block, Syracuse, N. Y.

Engineers, Civil, Hydraulic, Sanitary.
Will Engineers please to make out a list of separate headings under which they wish to be classified? We will do the best we can, without specifying every individual branch of practice in the profession.
Pages II. and III.

Engineers (Mechanical).
Smith, Jesse M., 36 Moffat Block, Detroit, Mich.

Engineers (Metallurgical).
Hunt and Clapp, 95 Fifth Ave., Pittsburg, Pa.

Engines (Gas).
Otto Gas Engine Works, Philadelphia, Pa.

Engines (Hoisting)
American Mfg. Co., So. Paul, Minn.
Beatty, M., & Sons, Welland, Ont.
Byers Machine Co., Jno. F., Ravenna, O.
Carlin's Sons, Thos., Allegheny, Pa.
Forsaith, S. C., Machine Co., Manchester, N. H.
Industrial Works, Bay City, Mich.
Lidgerwood Mfg. Co. 96 Liberty St., N. Y.
Mundy, J. S., Newark, N. J.
Pierce & Thomas, 42 Cortlandt St., F. Y. City.
Ryan-McDonald Mfg. Co., Baltimore, Md.

Engines (Steam).
Carlisle Mfg. Co., Carlisle, Pa.
Forsaith, S. C., Machine Co., Manchester, N. H.
Iredell, F. W., 10 Park Place, N. Y.
Poole, Robert, & Son Co., Baltimore, Md.
Southwark F'dry & Mach. Co., Philadelphia, Pa.

Engines (Traction).
Oastler, W. C., 43 Exchange Place, N. Y.
Poole, Robert, & Son Co., Baltimore, Md.
Porter Mfg. Co., Syracuse, N. Y.

Exhaust Pipe.
Abendroth & Root Mfg. Co., 28 Cliff St., N. Y.

Excavating Machinery for Sewers.
Carson Trench Machine Co., 21 Hamilton St., Boston, Mass.

Excavators.
Beatty, M. & Sons, Welland, Ont.
Bucyrus Foundry & Mfg. Co., Bucyrus O.
Marion Steam Shovel Co., Marion, O.
Osgood Dredge Co., Albany, N. Y.
Otis & Chapman, Boston, Mass.
Souther, John, & Co., Boston. Mass.
Toledo Foundry & Machine Co., Toledo, O.
San Francisco Bridge Co., San Francisco, Cal., and Seattle, Wash.

Explosives.
Rendrock Powder Co., 28 Park Row, New York.

Filters.
Jewell Filter Co., O. H., 73-75 W. Jackson St., Chicago.
Morison-Allen Co., 145 Broadway, New York.
National Water Purifying Co., 145 Broadway, New York.

Fire Brick and Clay, etc.
Iredell, F. W., 10 Park Place, New York.
Ohio Valley Fire Clay Co., Toronto, O.

Flue Linings.
Ohio Valley Fire Clay Co., Toronto, O.

Foundations (Deep and Difficult).
Anderson & Barr, 24 11th St., Jersey City, N. J.
Sooysmith & Co., 2 Nassau St., New York.

Freight Conveyors.
Industrial Works, Bay City, Mich.

Frogs.
Carlisle Mfg. Co., Carlisle, Pa.
Pennsylvania Steel Co., Steelton, Pa.
Ramapo Iron Works, Hillburn, N. Y.
Union Switch, & Signal Co., Swissvale, Pa.
Weir Frog Co., Cincinnati, O.

Furnaces.
Byram & Co., Detroit, Mich.

Gas Machinery.
Wood, R. D. & Co., 400 Chestnut St., Phila., Pa. C. A.: "Tuckahoe, Phila."

Gearing.
Poole, Robt. & Son Co., Baltimore, Md. C. A.: "Poole, Baltimore."
Edwin Harrington, Son & Co., 1508 Penna. Ave., Philadelphia Pa.

Geologist.
Smith, Frederick H., Baltimore, Md.

Gongs (Steam).
Union Water Meter Co., Worcester, Mass.

Grading Machines (Road).
Austen Mfg. Co., F. C., Chicago, Ill.

Grain Elevator Machinery.
Poole, Robt. & Son Co., Baltimore, Md. C. A.: "Poole, Baltimore."

Granite.
Booth Brothers & Hurricane Isle Granite Co., 60 Bank St., N. Y.
Southern Granite Co., Cincinnati, O., and Atlanta, Ga.

Graphite.
Dixon, Jos., Crucible Co., Jersey City, N. J.

Heavy Loam Castings.
Wood, R. D. & Co., 400 Chestnut St., Phila., Pa. C. A.: "Tuckahoe Phila."

Hoist. Horse Power.
American Mfg. Co., St. Paul, Minn.
Beatty M. & Sons.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Ryan-McDonald Mfg. Co., Baltimore, Md.

Hoisting Blocks.
Focht, Geo., 61 Adams St., Hoboken, N. J.
Mari- Machine Co., 2343 Callowhill St., Phila., Pa.
Byers Machine Co., Jno. F., Ravenna, O.

Hoisting & Conveying Machines.
Brown Hoisting & Conveying Machine Co., Cleveland, O.
Byers Machine Co., Jno. F., Ravenna, O.

Hoisting Buckets.
Focht, Geo., 61 Adams St., Hoboken, N. J.
Stuebner, G. L. & Co., 168-170 E. Third St., Long Island City, N. Y.

Hoop Machinery Hangers.
Toledo Foundry & Machine Co., Toledo, O.

Hydrant (Fire).
Beaumont, Richard, Kankakee, Ill.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Eddy Valve Co., Waterford, N. Y.
Flower, Jas., & Bro., Detroit, Mich.
Galvin Brass & Iron Works, Detroit, Mich.
Holly Mfg. Co., Lockport, N. Y.
Holyoke Hydrant & Iron Works, Holyoke, Mass.
Ludlow Valve Mfg. Co., Troy, N. Y. C. A.: "Ludvalco, Troy, N. Y."
Mellert Foundry & Machine Co., Reading, Pa.
Pancoast & Rogers, 15 Gold St., New York.
Rensselaer Mfg. Co., Troy, N. Y.
Union Hydraulic Works, Philadelphia, Pa.
Wood, R. D., & Co., 400 Chestnut St., Philadelphia.

Hydraulic Cranes. Lifts, etc.
Wood & Co., R. D., 400 Chestnut St., Philadelphia, Pa. C. A.: "Tuckahoe, Philadelphia."

Hydraulic Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.

Incandescent Electric Lighting.
Thomson-Houston Electric Co., Boston, Mass.

Injectors.
Forsaith, S. C., Machine Co., Manchester, N. H.
National Tube Works Co., New York.
Rue Mfg. Co., 116 No. 9th St., Philadelphia, Pa.

Ink (Sympathetic).
Stupakoff & Naegeley, Liberty and 9th St., Pittsburg, Pa.

Ink Erasing Pencil.
Monroe Eraser Mfg. Co., Lacrosse, Wis.

Inspection of Bridges and Rolling Stock.
Colby, J. A., Gerard Building, Philadelphia, Pa.
Estrada, Kenyon & Gray, Pittsburg, Pa.
Ferris & C., 9, W. 3d., Pittsburg, Pa.
Fuertes, Jas. H., Camden, Ark.
Hildreth & Co., R. W., 2 Wall St., N. Y.
Hunt & Clapp, 95 Fifth Ave., Pittsburg, Pa.
Laudreth, Olin H., Nashville, Tenn.
Meggeson & Wolff, 9th and Liberty Sts., Pittsburg, Pa.
Ricketts, Palmer C., 17 Fir 4 St., Troy, N. Y.
Robert W. Hunt & Co., Bureau of Inspection, Chicago, Ill.
Stebbins, W. L., 22 Fifth Ave., Chicago, Ill.

Instruments (Engineers and Surveyors).
Alteneder, T., 335 No. 10th St., Philadelphia, Pa.
Ball, Bennett & Co., Philadelphia, Pa.
Beckmann, L., Toledo, O.
Brightly, Chas. H., Germantown Junct., Philadelphia, Pa.
Buff & Burger, Boston, Mass.
Eddy, Geo M., Brooklyn, N. Y.
Fauth & Co., Washington, D. C.
Frost & Adams, 37 Cornhill, Boston, Mass.
Gurley, W. & L. E., Troy, N. Y.
Heer & Seelig, 194 Madison St., Chicago, Ill.
Heller & Brightly, Philadelphia, Pa.
Pfister, Herm., 195 W. Fifth St., Cincinnati, O.
Keuffel & Esser Co., 127 Fulton St., N. Y. C. A.: "Keuffel, N. Y."
Queen & Co., Philadelphia, Pa.
Raudebush, T. F., 57 W. Fourth St., Cincinnati, O.
Young & Sons, 43 N. Seventh St., Philadelphia.
C. N. Dunham & Co., Kansas City Mo.

Iron Foundry.
Focht, Geo., 51 Adams St., Hoboken, N. J.

Irrigating Hydrant.
Lacy Manufacturing Co., Los Angeles, Cal.

Irrigation Supplies.
Lacy Manufacturing Co., Los Angeles, Cal.

Joints (Rail).
The Q. & C. Co., Chicago.

Labor (Italian).
Crozzo, Donato, 60 Spring St., N. Y. City.

Lamp Posts.
Ohio Pipe Co., Columbus, O.
Wood & Co., R. D., 400 Chestnut St., Philadelphia, Pa.

Land Filling Machines.
San Francisco Bridge Co., San Francisco, Cal.

Landscape Architect.
Howell, D. J., National Union Building, Washington, D. C.
Ricker & Wing, 112 White Bldg., Buffalo, N. Y.

Liability Insurance Co.
The American Employers Liability Insurance Co., New York City.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
Evans, Geo. A., 40 Wall St., New York.
Iredell, F. W., 10 Park Place, N. Y. City.
Lima Machine Works, Lima, O.
Pittsburg Locomotive & Car Works, Pittsburg, Pa.
Porter, H. K., & Co., Pittsburg, Pa.
Richmond Locomotive & Machine Works, Richmond, Va.
Ryan-McDonald Mfg. Co., Baltimore, Md.

Locomotive Brakes.
American Brake Co., 160 Broadway, N. Y.

Log Loaders.
Marion Steam Shovel Co., Marion, O.

Lubricators.
Galvin Brass & Iron Works, Detroit, Mich.

Lumber (Car and Bridge).
Alfred J. Murray, New York.
Lehigh Vy. Creosoting Co., Washington St., Jersey City, N. J.
Vanderbilt & Hopkins, New York.

Machines (Coal Cutting).
Ingersoll-Sergeant Rock Drill Co., 10 Park Place, New York.

Machine (Sewer).
Brown Hoisting & Conveying Machine Co., Cleveland, O.

Machine Tools.
Forsaith, S. C., & Co., Manchester, N. H.
Harrington, E., & Son & Co., Philadelphia.

Machinery (Heavy Special).
Builders' Iron Foundry, Providence, R. I. C. A.: "Builders."

Machinists' Tools.
Stow Flexible Shaft Co. (Ltd.), Philadelphia, Pa.
Edwin Harrington, Son & Co., Philadelphia, Pa.

Malleable Iron Castings.
McConley & Torley Co., 48th St. A. V. burg, Pa. C. A.: "Torley, Pittsburg."

Measuring Tapes.
Eddy, Geo. M. & Co., 343-353 Classon Ave., Brooklyn, N. Y.

Meters (Water).
Hersey Mfg. Co., South Boston, Mass.
Thomson Meter Co., Temple Court, N. Y. City.
Union Water Meter Co., Worcester, Mass.
Worthington, Henry R., New York.
National Meter Co., 252 Broadway, New York.

Mill Architects.
Adams Engineering Co., Atlanta, Ga.

Mining Supplies.
Ingersoll-Sergeant Rock Drill Co., 10 Park Place, N.Y.
Rand Drill Co., New York City.

Mortar Colors.
Fisher, Erskine W., 18 Broadway, N. Y.
French, Samuel H. & Co., Philadelphia, Pa.
Tomkins, Calvin, 150 Broadway, N. Y.

Motors (Steam).
Porter & Co., H. K., Pittsburg, Pa.

Motors (Water).
Worthington, Henry R., 86-89 Liberty St., N. Y. C. A.: "Tuneharp, N. Y."
Pelton Water Wheel Co., 215 Franklin St., Boston.
Pelton Water Wheel Co., N. Y. City and San Francisco, Cal

Mixers.
Poole, Robert & Son Co., Baltimore, Md. C. A.: "Poole, Baltimore."

Packing.
Gould Packing Co., E. Cambridge, Mass.

Painters' and Builders' Supplies.
Dixon, Jos., Crucible Co., Jersey City, N. J.
French, Samuel H., & Co., Philadelphia, Pa.

Patent Law.
Bartlett, Wallace A., Washington, D. C.
Fitzgerald, W. T., Washington, D. C.
Smith, Jesse M., 36 Moffatt Block, Detroit, Mich.

Paving (Asphalt).
Barber Asphalt Paving Co., 1 Broadway, New York.
Hastings Pavement Co., 140 Pearl St., N. Y.
Neuchatel Asphalt Co., 265 Broadway, New York.
Sicilian Asphalt Paving Co., "Times" Building, New York. C. A.: "Ryquad, N. Y."
Warren-Scharf Asphalt Paving Co., 81 Fulton St., New York.
Wooton, E. H., 35 Broadway, New York.

Paving Block (Stone).
Booth Bros. and Hurricane Island Granite Co., 60 Bank St., N. Y.
Carpenter Bros., Port Chester, N. Y.
Southern Granite Co., Cincinnati, O., and Atlanta, Ga.

Paving Block (Wood).
Lehigh Vy. Creosoting Co., Washington St., Jersey City.

Paving Brick (Fire Clay).
Ohio Valley Fire Clay Co., Toronto, O.
United States Fire Clay Co., Pittsburg, Pa.

Paving Materials.
Southern Granite Co., Cincinnati, O., and Atlanta, Ga.
Tomkins, Calvin, 150 Broadway, N. Y.

Phosphor-Bronze.
Phosphor-Bronze Smelting Co., Limited, 512 Arch St., Philadelphia, Pa.

Pile Driving Machinery.
Beatty & Sons, M., Welland, Ont.
Cram, R. J. & A. B., Detroit, Mich.
Industrial Works, Bay City, Mich.
McEwen, A. C., 79 Morgan St., Jersey City, N. J.
Ryan-McDonald Mfg. Co., Baltimore, Md.
Toledo Foundry & Machine Co., Toledo, O.
Vulcan Iron Works Chicago, Ill.

Piles.
Lehigh Valley Creosoting Co., Washington St., Jersey City, N. J.
Murray, A. J., New York.

Pipe (Cast Iron).
Addyston Pipe and Steel Co., Addyston, O.
Chattanooga Foundry & Pipe Works, Chattanooga, Tenn.
Cleveland Pipe Works Co., Cleveland, O.
Detroit Pipe and Foundry Co., Detroit, Mich.
Donaldson Iron Co., Emaus, Pa.
Drummond, M. J., 192 Broadway, N. Y.
Glamorgan Company, Lynchburg, Va.
Jackson & Woodin Mfg. Co., Berwick, Pa.
Long & Co., Dennis, Louisville, Ky.
Lake Shore Foundry, Cleveland, O.
McNeal Foundry & Pipe Co., Burlington, N. J.
Mellert Foundry & Machine Co., Reading, Pa.
Millar, Chas. & Son, Utica, N. Y.
National Foundry & Pipe Works, Scottdale, Pa.
Ohio Pipe Co., Columbus, O.
Pancoast & Rogers, 28 Platt St., New York.
Radford Pipe and Fdry Co., Cincinnati, O.
Shickle, Harrison & Howard Iron Co., St. Louis, Mo.
Union Hydraulic Works, Germantown Ave. and Second St., Philadelphia, Pa.
Warren Foundry & Machine Co., 160 Broadway, New York.
Wood, R. D., & Co., 400 Chestnut St., Phila., Pa.

Pipe (Culvert).
Blackmer & Post, St. Louis Mo.
Lookout Sewer Pipe Co., Chattanoogs, Tenn.
McMahan, Porter & Co., New Cumberland, W. Va.

Pipe (Lead).
Millar, Chas. & Son, Utica, N. Y.

Pipe, Riveted Sheet Steel and Iron.
Lacy Manufacturing Co., Los Angeles, Cal.

Pipe (Wrought Iron).
National Tube Works Co., McKeesport, Pa.
Rochester Bridge and Iron Works, Rochester, N. Y.
Sumner & Goodwin, 15 Oliver St., Boston.
Pipe (Wyckoff Water).
Michigan Pipe Co., Bay City, Mich.

Pipe Laying (Contractors).
Foley, John T., Nashville, Tenn.
Harlow & Co., J. H., Pittsburg, Pa.

Pipe Loaders.
Marion Steam Shovel Co., Marion, O.

Polishing Tools. Metal and Wood.
Stow Flexible Shaft Co., Philadelphia, Pa.

Portable Drills. Tapping & Boring Tools.
Stow Flexible Shaft Co. (Ltd.), Philadelphia, Pa.

Power Hammers.
Forsaith & Co., S. C., Manchester, N. H.
Dienelt & Eisenhardt, 1306 Howard St., Philadelphia, Pa.

Pressure Regulators (Water.)
Curtis Regulator Co., Boston, Mass.
Union Water Meter Co., Worcester, Mass.

Prospecting Drills. Electric.
Edison Gen'l Electric Co., Edison Bldg., N. Y. City.

Protection of Drawbridges. Appliances for.
Union Switch & Signal Co., Pittsburg, Pa.

Pulley Blocks. Chain Screw.
Edwin Harrington, Son & Co., Philadelphia, Pa.

Pulleys & Hill Clutch Pulleys.
Maris Machine Co., Philadelphia, Pa.

Pulley Hub Drilling Machine.
Stow Flexible Shaft Co. (Ltd.), Philadelphia, Pa.

Pumps & Pumping Machinery.
Barr Pumping Engine Co., Philadelphia, Pa.
Buffalo Steam Pump Co., The, Buffalo, N. Y.
Cameron, A. S., Steam Pump Wks, ft. of 23d St., N. Y.
Davidson Steam Pump Co., 77 Liberty St., N. Y.
Deane Steam Pump Co., The, Holyoke, Mass.
Dean Bros.' Steam Pump Works, Indianapolis, Ind.
Forsaith, S. C., Manchester, N. H.
Gordon Steam Pump Co., The, Hamilton, O.
Holly Mfg. Co., Lockport, N. Y.
Hugnes Steam Pump Co., Cleveland, O.
Laidlaw & Dunn Co., The, Cincinnati, O.
Maslin, John & Son, Jersey City, N. J.
Norwalk Iron Wks. Co., The, Norwalk, Conn.
Nye, Geo. E., 76 Washington St., Chicago.
Oil Well & Supply Co., Limited, 82 Fulton St., N. Y.
Pond Engineering Co., St. Louis, Mo.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Smith and Valle Co., Dayton, O.
Southwark Fdry & Mach. Co., Phila., Pa.
Valley Pump Co., Easthampton, Mass.
Worthington, Henry R., New York.
Van Duzen & Tift, Cincinnati, O.

Pumps (Centrifugal).
Beatty, M. & Sons, Welland, Ont.
Edwards, Joseph & Co., 412 Water St., N. Y.
Southwark Fdry & Machine Co.
Van Wie, Irwin, Syracuse, N. Y.

Pumps (Hand Power).
Boston & Lockport Block Co., Boston, Mass.

Pumps, Electric.
Thomson-Houston Motor Co., Boston, Mass.

Pumps (Vacuum).
Clayton Air Compressor Wks., 43 Dey St., N. Y. C. A.: "Compressor, Brklyn."

Punched and Rolled Pipe.
Abendroth & Root Mfg. Co., 28 Cliff St., N. Y. C. A.: "Dogpalace, N. Y."

Purchasing Agents.
Iredell, F. W., 10 Park Place, N. Y.

Quarrying Machinery.
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Wood Working Machinery.
Forsaith, S. C., & Co., Manchester, N. H.

List of Inset Drawings Published in Engineering News, Jan. 1, 1890, to June 27, 1891.

1 Head Gates and Booms of Main Canal, Dolores, Col.
2 Portrait of Horatio Allen.
3 Freight Car Transfer Bridge, P. R. R., Harsimus Cove, Jersey City.
4 The Forth Bridge: View of Fife Piers and Cantilevers.
5 The St. Guistina Viaduct in the Southern Tyrol.
6 { Sewage Pumping Engines, Hull, Eng. / Standard Station, Harlem Depression, N. Y. C. & H. R. R. R.
7 Standard Overtrack Station, Harlem Depression, N. Y. C & H. R. R. R.
8 Cable Railway Tunnel Under Chicago River, Chicago.
9 Colored R. R. Map.
10 Portrait of W. J. McAlpine.
11 The Winner Bridge at Kansas City, Mo.
12 Reservoir "M" on Titicus River, N. Y. Water Supply.
13 Design for the Grand-Stand at Monmouth Park, N. J.
14 Bridge over the Kentucky River, Louisville Southern R. R.
15 Colored Map R. R. Construction.
16 Side Dump Car, 80,000 lbs. capacity, Erie R. R.
17 Howe Truss Bridge, 30 ft. to 150 ft. span, Oregon Pacific R. R.
18 Baldwin Compound Locomotive.
19 New Water-Works for Covington, Ky
20 " " " " "
" Portrait of Moses Lane.
21 Minor Structures, C. P. Ry.
22 Triple-Expansion Pumping Engine, Chicago Water-Works.
23 Colored Map R. R. Construction.
24 " " " "
25 Dams and Reservoir Embankments for Water-Works
26 Class "H" Locomotive, C., B. & Q. R. R.
27 The New Water-Works, Chicago, Ill.
28 The Russell Snow Plow, Intercolonial Ry.
29 Missouri River Bridge, K., C. Bridge & Terminal Ry.
30 Lighthouse for Outer Diamond Shoals off Cape Hatteras.
31 Colored Map R. R. Construction.
32 The Diamond Shoal Lighthouse.
33 Pile Driving and Ditching Plant Omaha & St. L. Ry.
34 Electric Light Car P. R. R.
35 Ten-Wheel Locomotive C. P. Ry.
36 Diagrams of Hydraulic Formulas.
37 The Keswick Water-Power Electric Light Station.
38 Ohio Connecting Ry. Bridge at Pittsburg, Pa.
39 Colored R. R. Map.
40 Red Rock Cantilever Bridge.
41 Portrait of A. L. Holley.
42 Denver, Colo., Canon & Pacific Ry. Project.
43 Approved Plans for Storm Sewers, Duluth, Minn.
44 Pipes, Conduits, etc., Broadway & Fulton St., N. Y. City.
45 The St. Clair Tunnel.
46 The New Croton Dam.
47 New York Water Supply, Illustrated.
48 Colored R. R. Map.
49 St. Clair Tunnel.
50 Track Details, Third Ave. Cable Ry., N.Y.
51 Portrait of Wm. P. Shinn.
52 Some of the Designs Submitted for Washington Bridge over the Harlem River.

1891.

1 Colored R. R. Map.
2 1,200-Ton Testing Machine at Phœnixville, Pa.
3 Passenger Elevators of North Hudson Co. Ry. at Weehawken.
4 Bridge Details, C., K. C. & Tex. Ry.
5 Designs for the Fort St. R. R. Station, Detroit, Mich.
6 Substructure Cairo Bridge, Ill., Central Ry.
7 Missouri Pacific Ry. Bridges.
8 Progress Report on Standard Rail Sections.
9 Colored R. R. Map.
10 Brooklyn Water Works Extension.
11 Metropolitan Underground Ry. Co's Tunnel under East River.
12 Standard Rail Sections.
13 Express Passenger Locomotive, L. & Y. R. R., England.
14 Caissons and Cribs for Quindaro Bridge.
15 Colored R. R. Construction Map.
16 Settling Basins, St. Louis Water Works.
17 Equipment of Freight Cars with M. C. B. Auto. Couplers.
18 Equipment of Freight Cars with Westinghouse Air Brake.
19 Brooklyn Water Works Extension.
20 Walnut St. Bridge at Chattanooga, Tenn.
21 Portrait of Octave Chanute.
22 Draw Span and Pivot Pier Coteau Bridge.
23 Brooklyn Water-Works Extension.
24 Colored R. R. Construction Map.
25 The Ainsley-Oakes Square Hole Drilling Machine.
Grand Ave Bridge, St. Louis, Mo.

An examination of the above list will show what a broad field of engineering has been illustrated. It is not necessary to recapitulate. These drawings, moreover, are not pictures; with the exceptions of the portraits the colored maps of railroad construction, and one or two others, they are detailed drawings of novel structures, fully figured as to dimensions, and together forming, without exception, the most valuable album of engineering drawings ever produced in this country. Together with the descriptive matter, they are of themselves worth many times the yearly subscription price of the paper of which they are so small a portion. Does the reader realize the amount of careful, painstaking, expert labor expended on these drawings—the compiling from blue prints of all sizes and scales, or from the original tracings; the caution necessary in entering the dimensions; the uniform neatness demanded; then the selection of paper and the care of the presswork till all is completed? If we did not have to print so large an edition it would be out of the question to attempt it, as each map would cost too much to warrant the expenditure.

These insets are a permanent feature of this journal, and our continual effort will be to secure the most deserving subjects, and to present them with such excellence of workmanship and accuracy of detail that they will be quite unapproachable by any other journal in the world, as indeed they almost are now. To the practicing engineer these drawings are invaluable for reference and study, as they are the results of the study of the men most eminent in their several branches of engineering.

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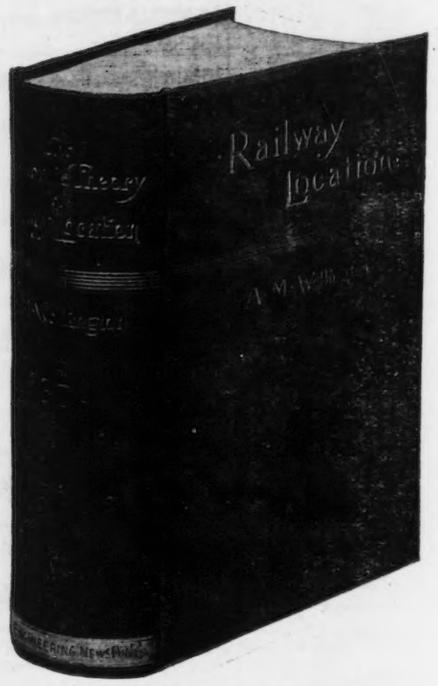

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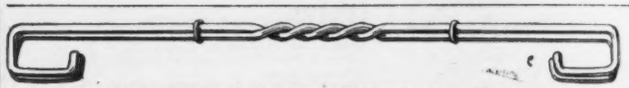

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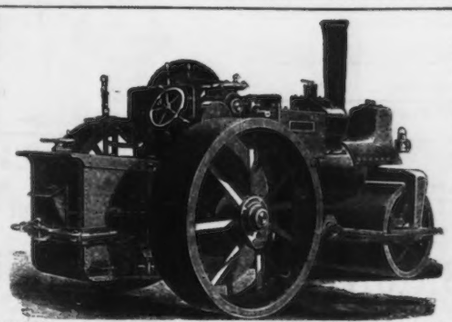

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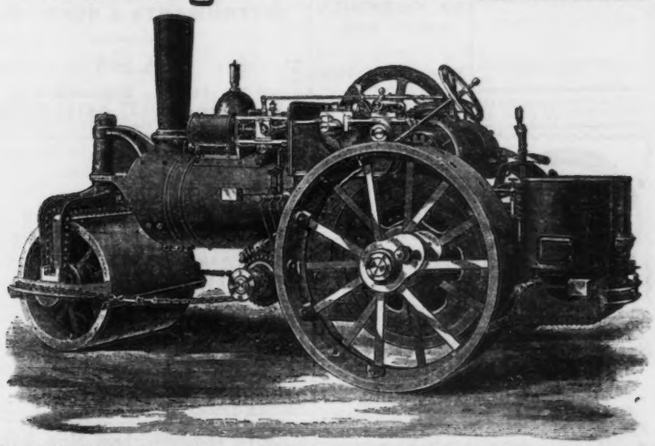

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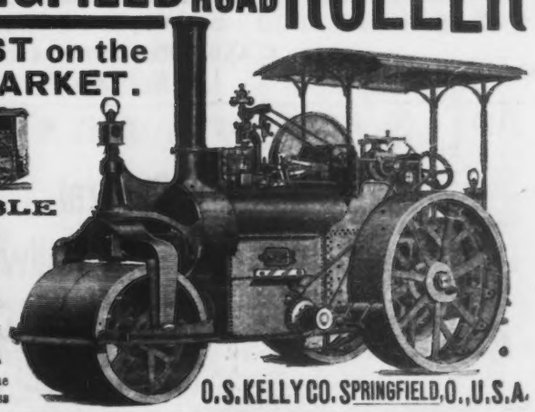

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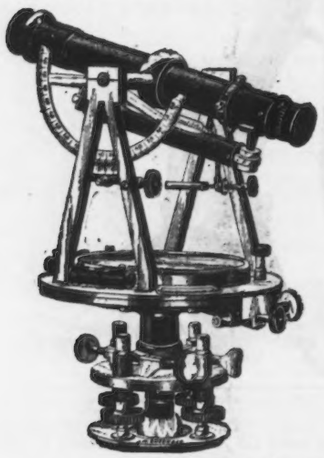

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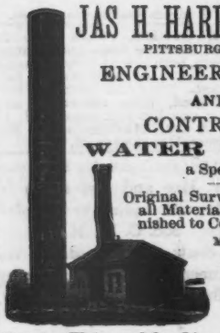

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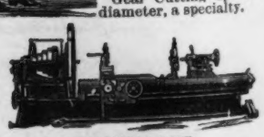

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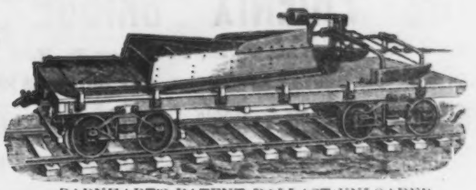

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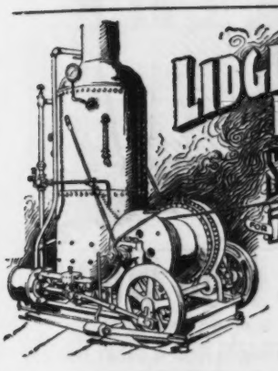

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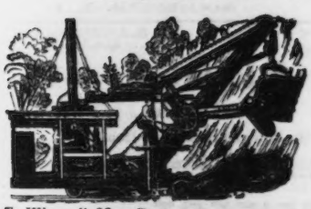

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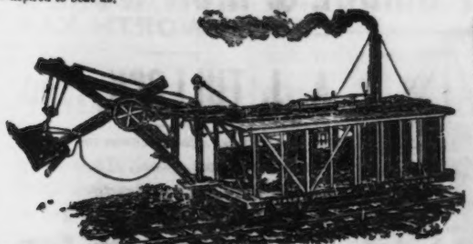

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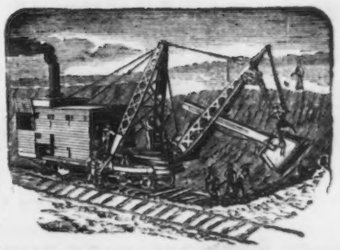

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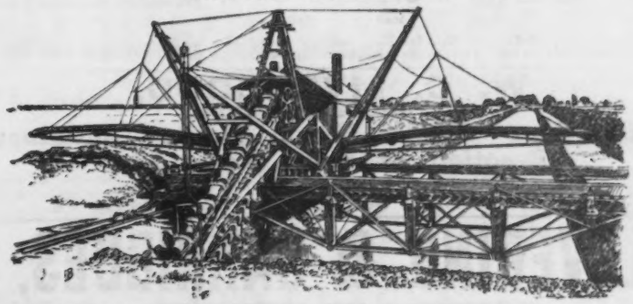

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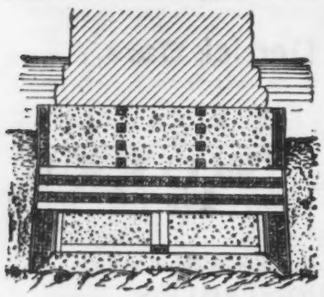

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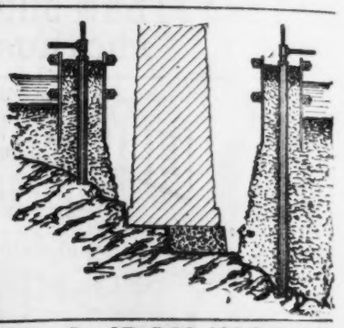

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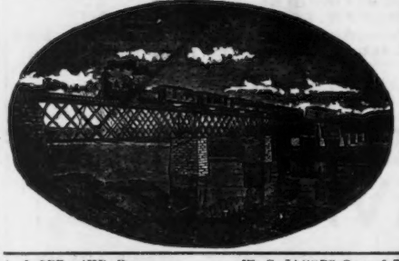

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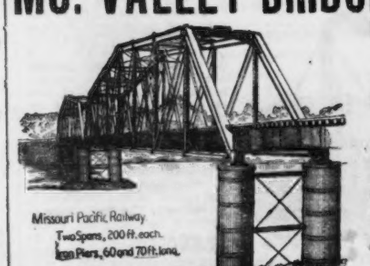

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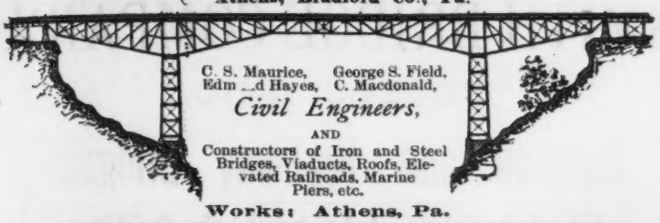

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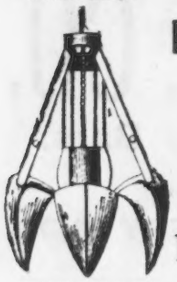

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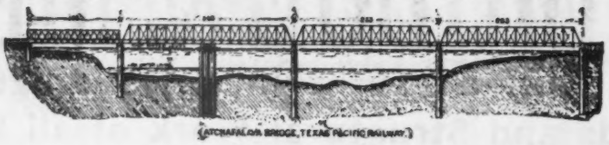

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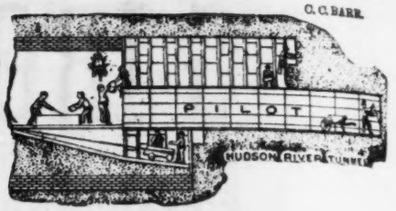

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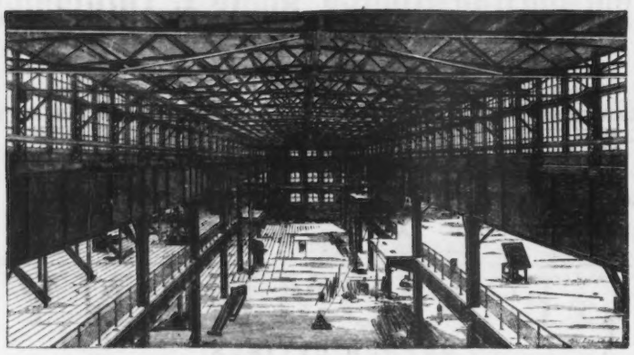

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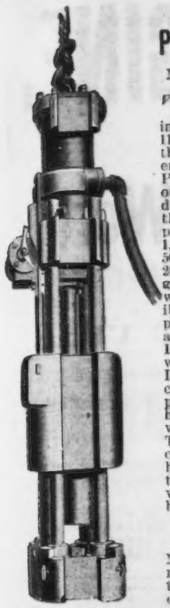

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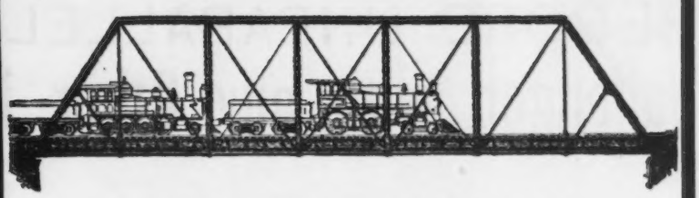

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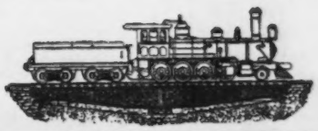

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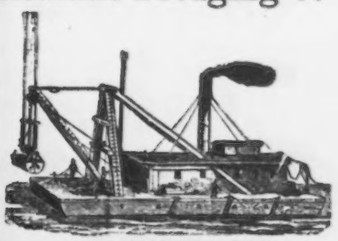

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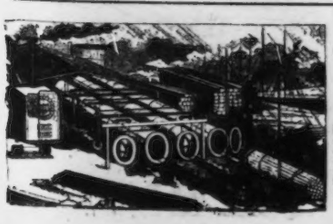

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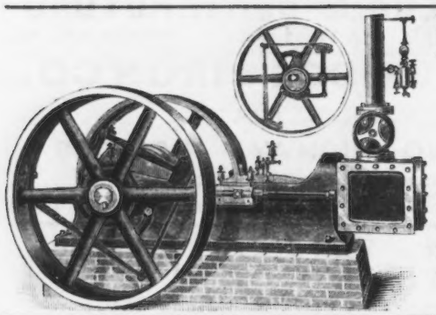

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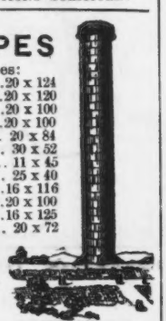

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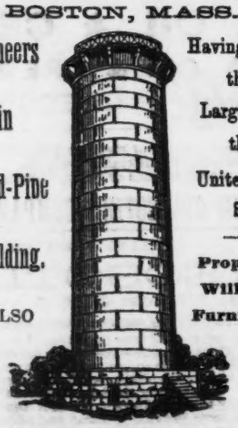

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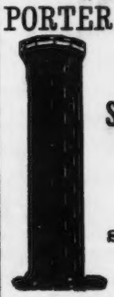

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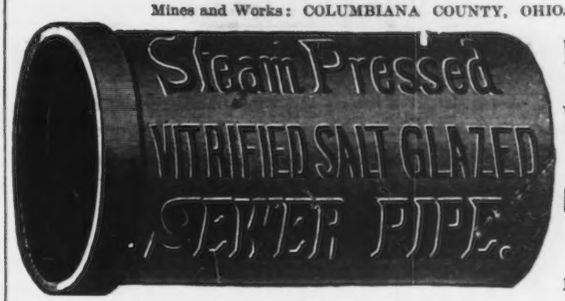

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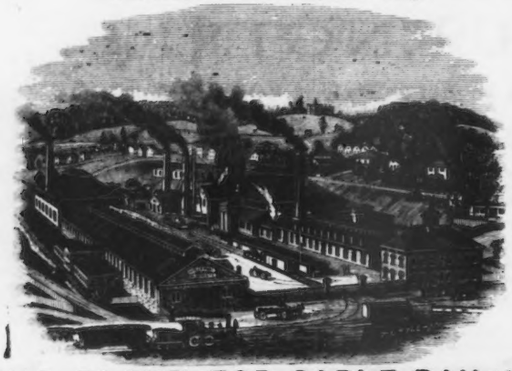

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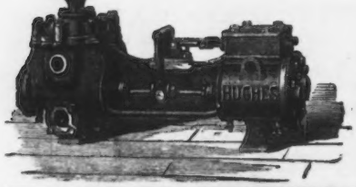

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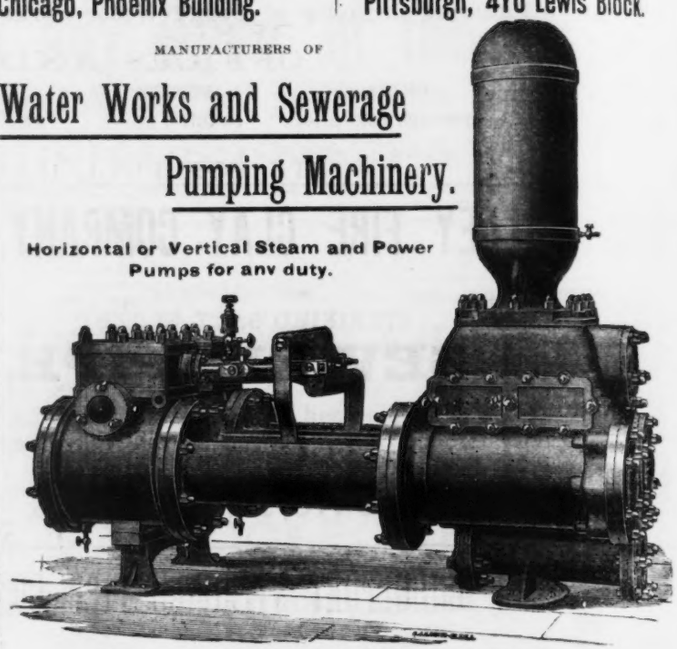

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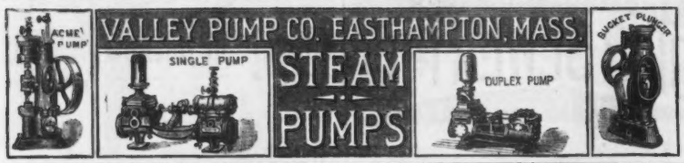

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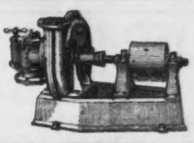

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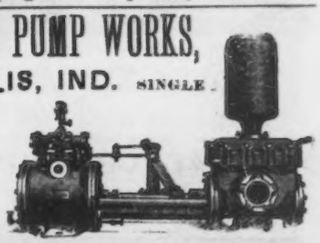

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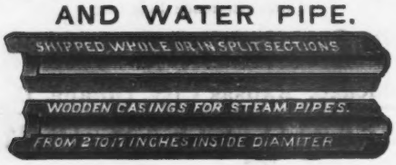

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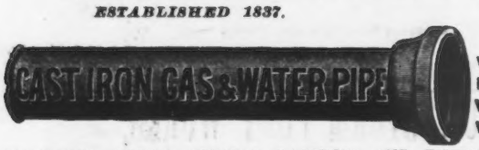

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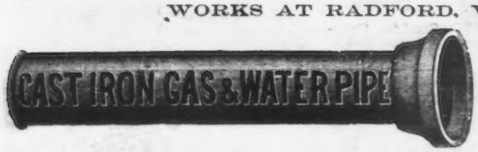

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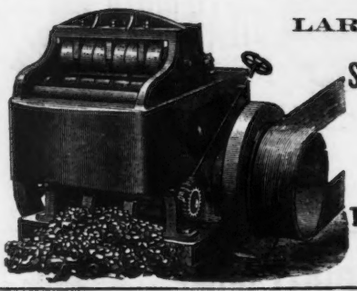

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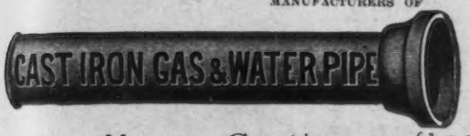

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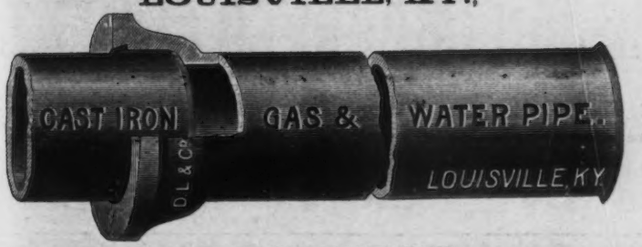

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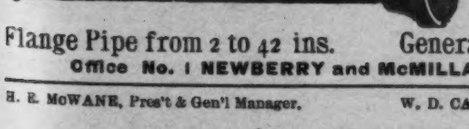

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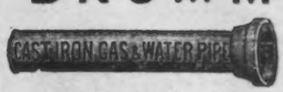

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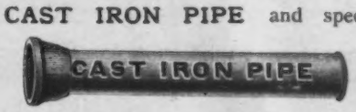
WATER 

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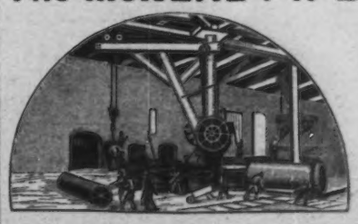

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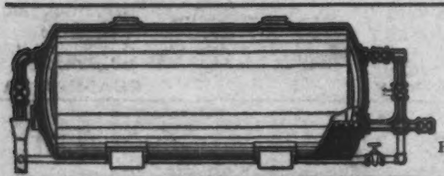

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Owing to increased sales we have been enabled to reduce our prices. Send for Catalogue to

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MADE UNDER OUR

System of Comparative Tests without one Case of Breakage in Service.

We contract to regrind our wheels at points of removal, saving freight and increasing total life of wheels from 100 to 300 per cent.

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James J. Ryan, Contractor, Office 1126 N. 40 St., Phila.

AMERICAN IMPROVED CEMENTS CO.: PHILADELPHIA, March 14, 1888.

DEAR SIRS: I have used about thirty thousand (30,000) barrels of your Improved Union Cement, also several hundred barrels of your Giant Portland Cement, in the construction of Pennsylvania Avenue Section of the P. & O. Tunnel in this city. I can cheerfully recommend both branches to be equal to any American manufacture of cement, and to be a first-class article.

Yours truly,

(Signed) JAMES J. RYAN.

LESLEY & TRINKLE, Sales Agents, 220 South Third St., Philadelphia.

CONTRACTORS ON PUBLIC WORKS

And others who are **OUR CUSTOMERS** use our machines for digging and back-filling sewer and similar trenches because they work by the **MOST ECONOMICAL** method. Their use systematizes the work and is most convenient for the **PUBLIC.** For further information address

CARSON TRENCH MACHINE CO., 16 Dorrance St., Charlestown District, Boston, Mass.

F. O. NORTON'S Cement was Used for Pointing.

F. Collingwood, Esq., Asst. Engr., writes:

"We used large quantities of your Cement in pointing the masonry of the East River Bridge, and always with satisfactory results, provided the proper precautions were taken to insure good work. * * * The pointing on the Brooklyn Tower has withstood the weather now for some fourteen years, and you can refer to it with confidence that it will bear out what I have said." *F. O. NORTON, Manufacturer, 99 Broadway, New York.*

LAWRENCE CEMENT CO

The Oldest Cement Establishment in the United States,

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MANUFACTURERS OF THE

"HOFFMAN" ROSENDALE CEMENT

SUPERIOR FOR WORK UNDER WATER.

STANDS AT THE HEAD OF AMERICAN CEMENTS FOR

TENSILE STRAIN,

UNIFORM QUALITY,

INCREASING STRENGTH.

EXTENSIVELY USED BY THE U. S. GOVERNMENT.

Sales in the United States, 6,000,000 Barrels.

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ALSEN'S PORTLAND CEMENT.

Tests made under Col. D. C. HOUSTON, Corps of Engineers, U. S. A., of Alsen's Cement used for sea wall around Governor's Island, New York Harbor.

Tensile strength per square inch, 1 day, 384 lbs.; 7 days, 600 lbs.; 30 days, 818 lbs.

Alsen's Portland Cement Works, "Post Bldg.," 18 Exchange Place, N.Y.

STEEL RAILS.

STANDARD SECTIONS	50	TO	80	LBS.	PER YARD
LIGHT	16	TO	45	"	"
STREET RAILS	30	TO	88	"	"

Pennsylvania Steel Co.,

2 Wall St., cor. Broadway, New York City.

STEPHEN W. BALDWIN, Sales Agent.

THE BARBER ASPHALT PAVING COMPANY.

The extent of pavements laid by this company prior to Jan. 1, 1891, is as follows:

Cities.	Sq. Yds.	Cities.	Sq. Yds.
Washington..	807,710	Erie.....	99,962
Baltimore	31,188	Youngstown..	23,177
Philadelphia..	81,864	Fort Wayne..	16,309
New York.....	197,816	Chicago.....	129,949
Long Is'd City	1,724	Omaha.....	431,517
Newark.....	13,429	Denver.....	7,333
Boston.....	45,225	St. Joseph.....	120,363
Albany.....	57,159	Topeka.....	194,633
Schenectady..	9,362	Kansas City...	106,606
Lockport.....	13,701	Wyandotte....	29,652
Buffalo.....	1,547,385	Wichita.....	56,176
Scranton.....	106,003	St. Louis.....	36,251
Wilkesbarre..	83,888	Louisville....	125,494
Harrisburg...	42,159	New Orleans..	151,817
Altoona.....	33,789		
Dunkirk.....	909	Total.....	4,653,061

Or an equivalent of 307 miles of roadway, 26 ft. wide.

ITS ADVANTAGES:

Durability, Smoothness, Health, Safety, Noiselessness, Popularity, Cheapness.

It is the only pavement which in this country can to-day show 307 miles of surface in first-class order. It is the standard pavement of America.

It will save 30 to 40 per cent. of the cost of transporting passengers and goods in any city.

It will save 50 to 75 per cent. of repair to vehicles.

It saves human nerves and health, and adds to the comfort of every person who uses a carriage.

This company has laid asphalt pavement in 30 cities of the United States, on 618 streets.

It has taken up other pavements and replaced them with Trinidad Asphalt Pavement to the following extent:

Wood.....	504,272 square yards
Stone.....	416,986 " "
French Rock Asphalt....	32,196 "
Coal Tar and Vulcanite .	90,000 "
Macadam.....	463,101 "
Total.....	1,570,783 square yards

The localities where this substitution has been made are noted in the preceding list of streets. The Barber Asphalt Paving Company has laid its Trinidad Asphalt Pavement upon Macadam, Stone block and Asphalt block foundation to the following extent:

Upon old Macadam foundation,	95,118	sq. yds.	
" Stone block "	88,859	"	
" Asphalt "	16,325	"	
Total.....	200,302	"	

For plans and estimates apply to the general offices of the Barber Asphalt Paving Comp
A. L. BARBER, President, Le Droit Building, Washington, D. C.
F. V. GREENE, Vice-President, Washington Building, 1 Broadway, New York.

Washington, 15 Le Droit Building; New York, 1 Broadway; Philadelphia, 451 North Thirtieth St.; Boston, 12 Pear St.; Buffalo, Chapin Block; St. Joseph, 513 Francis St.; Topeka, 700 Kansas Ave.; Kansas City, 818 Wyandotte St.; St. Louis, 113 North Eighth St.; Louisville, 32 Bull Block; New Orleans, 71 Baronne St.; Chicago, Opera House; Omaha, Ramage Block.